Lake Metonga

Forest County, Wisconsin

Aquatic Plant Management Plan

December 2007

Sponsored by:

Lake Metonga Association

LPL-1178-07

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Onterra, LLC
Lake Management Planning

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Funded by: Lake Metonga Association, Inc.
Wisconsin Dept. of Natural Resources (LPL-1178-07)

Acknowledgements

This management planning effort was truly a team-based project and could not have been completed without the input of the following individuals:

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Mr. Harold Resch
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INTRODUCTION

Lake Metonga, Forest County, is a 2,157-acre drainage lake with a maximum depth of 79 feet and a mean depth of 25 feet. Outlet Creek, Lake Metonga's outlet, leads to the Swamp Creek which flows through Rice Lake on its way to the Wolf River. Rice Lake, one of the few lakes located on the Sokaogon Chippewa Reservation, is a valuable resource for the native community which harvests wild rice on its waters.

Lake Metonga, by virtue of its size, is a popular recreational lake and tourist destination. Arguably, it is this factor which has caused Lake Metonga to become infested with invasive species such as rusty crayfish, zebra mussels, and Eurasian water milfoil. Since 1998, the Lake Metonga Association (LMA) has been engaged in a management effort to reduce the amount and density of Eurasian water milfoil in the lake through 2,4-D chemical applications and biological control introductions. Since 2005, the management activities were conducted under the auspices of a WDNR AIS Grant, which the LMA was awarded, to cover costs associated with the planning, application, and monitoring of Eurasian water milfoil control. With both success and failures reported from the chemical treatments in Lake Metonga, the LMA decided to move toward more of an ecosystem-approach of managing their lake. They were awarded a WDNR Planning Grant to provide financial support for the planning project.

The primary goal of this project was to complete a *Comprehensive Management Plan* for Lake Metonga. Studies designed to collect baseline information concerning the lake's water quality, its native and non-native plant communities, and its watershed were be used with historic data concerning those components and that of the lake's fishery to reach conclusions regarding the health and function of the lake as an ecosystem. That information, along with information obtained through the efforts for the stakeholder participation component was combined to devise a long-term and realistic management plan for Lake Metonga.

STAKEHOLDER PARTICIPATION

Stakeholder participation is an important part of any management planning exercise. During this project, stakeholders were not only informed about the project and its results, but also introduced to important concepts in lake ecology. Stakeholders were also informed about how their use of the lake's shorelands and open water areas impact the lake. Stakeholder input regarding the development of this plan was obtained through communications and meetings with the Lake Metonga Association and via a stakeholder survey. A description of each stakeholder participation event can be found below, while supporting materials can be found in Appendix A. Lester Schramm, the authorized representative of the LMA planning project, has continually updated the LMA board of directors on the status of the planning project.

Newsletters and Special Mailings

A newsletter article written by the LMA in spring 2007 introduced the planning process that was underway. This article mentioned that a Kick-off Meeting would occur and that the LMA would need to solicit members to serve on a planning committee. In September, a special mailing was sent to association members announcing the Kick-off Meeting and explaining the important components that would be discussed at the meeting. LMA's fall 2007 newsletter summarized the Kick-off Meeting, discussed the progress of the management plan, and provided some preliminary data relating to the number of returned stakeholder surveys.

Kick-off Meeting

On October 6, 2007 the LMA held a special meeting to inform association members and other interested parties about the lake management planning project the association was undertaking. During the meeting, Eddie Heath, an ecologist with Onterra, presented information about lake eutrophication, native and non-native aquatic plants, the importance of lake management planning, and the goals and components of the Lake Metonga management planning project. It was anticipated that the management plan would largely focus on Eurasian water milfoil; therefore, the history of Eurasian water milfoil treatments on Lake Metonga was discussed. At this meeting, Eddie announced that a stakeholder survey would soon be sent to association members and riparians to better understand the views of Lake Metonga stakeholders.

Stakeholder Survey

During October 2007, a four-page, 23-question survey was mailed to 268 Lake Metonga stakeholders. The mailing included all riparian property owners and all off lake members of the LMA. Over 60% of the surveys were returned and those results were entered into an Onterra-provided spreadsheet by members of the LMA Planning Committee. The data were summarized and analyzed by Onterra for use at the planning meeting and within the management plan. The full survey and results can be found in Appendix B, while discussion of those results is integrated within the appropriate sections of the management plan.

Planning Committee Meeting

On November 14, 2007, Tim Hoyman and Eddie Heath of Onterra met with eight members of the Lake Metonga Planning Committee for a little over 3½ hours. The primary focus of this meeting was the delivery of the study results and conclusions to the committee. All study components including, Eurasian water milfoil treatment results, aquatic plant inventories, water quality analysis, watershed modeling, and the stakeholder survey were presented and discussed. Eurasian water milfoil control was presented as the primary concern of the planning committee.

Project Wrap-up Meeting

On July 19, 2008 Eddie Heath of Onterra met with 26 members of the Lake Metonga Association for approximately 2½ hours to deliver the results of the lake management planning project. Similar to the Planning Committee Meeting, all study components were presented and discussed, albeit in a manner more conducive to the larger audience. The presentation concluded with a description of the Implementation Plan that was developed with the Planning Committee. Approximately 30 minutes of questions followed the presentation.

RESULTS & DISCUSSION

Lake Water Quality

Judging the quality of lake water can be difficult because lakes display problems in many different ways. However, focusing on specific aspects or parameters that are important to lake ecology, comparing those values to similar lakes within the same region, and historical data from the study lake provides an excellent method to evaluate the quality of a lake's water. To complete this task, three water quality parameters are focused upon within this document:

Phosphorus is a nutrient that controls the growth of plants in the vast majority of Wisconsin lakes. It is important to remember that in lakes, the term "plants" includes both *algae* and *macrophytes*. Monitoring and evaluating concentrations of phosphorus within the lake helps to create a better understanding of the current and potential growth rates of the plants within the lake.

Chlorophyll-*a* is the green pigment in plants used during *photosynthesis*. Chlorophyll-*a* concentrations are directly related to the abundance of free-floating algae in the lake. Chlorophyll-*a* values increase during algal blooms.

Secchi disk transparency is a measurement of water clarity. Of all limnological parameters, it is the most used and the easiest for non-professionals to understand. Furthermore, measuring Secchi disk transparency over long periods of time is one of the best methods of monitoring the health of a lake. The measurement is conducted by lowering a weighted, 20-cm diameter disk with alternating black and white quadrates (a Secchi disk) into the water and recording the depth just before it disappears from sight.

The parameters described above are interrelated. Phosphorus controls algal abundance, which is measured by chlorophyll-*a* levels. Water clarity, as measured by Secchi disk transparency, is directly affected by the particulates that are suspended in the water. In the majority of natural, Wisconsin lakes, the primary particulate matter is algae; therefore, algal abundance directly affects water clarity. In addition, studies have shown that water clarity is used by most lake users to judge water quality – clear water equals clean water.

Each of these parameters is also directly related to the *trophic state* of the lake. As nutrients, primarily phosphorus, accumulate within a lake, its productivity increases and the lake progresses through three trophic states: *oligotrophic*, *mesotrophic*, and finally *eutrophic*. Every lake will naturally progress through these states; however, under natural conditions (i.e. not influenced by the activities of humans) this progress can take tens of thousands of years. Unfortunately, human influence has accelerated this natural aging process in most Wisconsin lakes. Monitoring the trophic state of a lake gives stakeholders a method by which to gauge the health of their lake over time. Yet, classifying a lake into one of three trophic states does not give clear indication of where a lake really exists in its trophic progression. To solve this problem, the parameters described above can be used in an index that will specify a lake's trophic state more clearly and provide a means for which to track it over time.

The complete results of these three parameters and the other chemical data that were collected at Lake Metonga can be found in Appendix C. The results and discussion of the analysis and comparisons described above can be found in the paragraphs and figures that follow.

Comparisons with Other Datasets

Lillie and Mason (1983) is an excellent source for comparing lakes within specific regions of Wisconsin. They divided the state's lakes into five regions each having lakes of similar nature or apparent characteristics. Forest County lakes are included within the study's Northeast Region (Figure 1) and are among 242 lakes randomly picked from the region that were analyzed for water clarity (Secchi disk), chlorophyll-*a*, and total phosphorus. These data along with data corresponding to statewide natural lake means, historic, current, and average data from Lake Metonga are displayed in Figures 2-4. Please note that the data in these graphs represent concentrations and depths taken only during the growing season (April-October) or summer months (June-August). Furthermore, the phosphorus and chlorophyll-a data represent only surface samples. Surface samples are used because they represent the depths at which algae grow and depths at which phosphorus levels are not greatly influenced by phosphorus being released from bottom sediments.

Figure 1. Location of Lake Metonga within the regions utilized by Lillie and Mason (1983).

Since 1999, there is a good amount of data available for Lake Metonga, primarily because of the Citizens Lake Monitoring Network. Secchi depth transparency data is available since 1992. A summary of the available data is provided in Appendix C.

Total phosphorus values in Lake Metonga (Figure 3) have been relatively stable since 1999 and have been on the boundary of the very good and good range as compared to the Wisconsin Water Quality Index (WQI) (Lillie and Mason 1983). By this index, the weighted means total phosphorus values are lower than the average of Wisconsin natural lakes and the average of the Lillie and Mason region.

Chlorophyll-*a* values for the same time period (Figure 4) have also been relatively stable since 1999 and with the exception of 2000 values, have been in the very good or excellent range as compared to the WQI (Lillie and Mason 1983). These values are considerably lower than the Wisconsin natural lakes and Northeast Region means.

Secchi disk clarities span from the early 1990s to 2007 and indicate that although the values fluctuate from year to year, they are all again within the very good to excellent range. Within the past decade, Secchi values were the lowest in 2001, incidentally the same year that zebra mussels were discovered by WDNR staff in Lake Metonga. Although transparency levels were significantly greater in 2005-2006, the 2007 values show that the data may be explained by a cyclic trend linked to precipitation or some other factor rather than a deviation from normal. Lake Metonga's Secchi disk clarity values are far greater than the average values found in the Wisconsin natural lakes and Northeast Region.

Overall, the water quality of Lake Metonga is very good. Even in years with higher than normal runoff, the lake responds well and maintains good clarity values. In fact, in all years, the water quality of Lake Metonga is better than the average values found in the Northeast Region and from Wisconsin natural lakes. As explained in the Watershed Assessment section, the lakes small watershed and incredible volume are the most prominent factor in the lake's good water quality. However, non-native aquatic species like Eurasian water milfoil, zebra mussels, and rusty crayfish can have an influence on the physical and chemical characteristics of the water quality in Lake Metonga.

Lake Metonga Trophic State

Figure 5 displays the Wisconsin Trophic State Index (WTSI) (Lillie et al. 1993) values calculated from average surface levels of chlorophyll-*a*, total phosphorus, and Secchi disk transparencies measured during the summer months in Lake Metonga The WTSI is based upon the widely used Carlson Trophic State Index (TSI) (Carlson 1977), but is specific to Wisconsin lakes. In essence, a trophic state index is a mathematical procedure that assigns an index number that corresponds to a lake's trophic state based upon three common lake parameters; chlorophyll-*a*, Secchi disk transparency, and total phosphorus. The WTSI is used extensively by the WDNR and is reported along with lake data collected by WDNR Citizen Lake Monitoring Network volunteers.

The trophic state of a lake is directly related to its production, more precisely – primary production. It is simply a classification based upon the lake's capacity to produce plants in the form of algae and macrophytes. By examining a lake's nitrogen to phosphorus ratio, the nutrient that is scarce or limiting to the system can be understood. An overwhelming majority of Wisconsin Lakes are phosphorus limited (Lillie and Mason 1983). Although there is no available nitrogen data for Lake Metonga, it is highly likely that it is phosphorus limited: therefore, as more phosphorus is added to the lake, its production capacity increases as does its trophic state.

The WTSI values for Lake Metonga indicate the lake to be oligotrophic-mesotrophic. In a phosphorus limited system, the WTSI values for total phosphorus are usually the strongest metric and show that the lake is strongly mesotrophic. Based on these data, the trophic state of Lake Metonga is most likely mesotrophic, but definitely closer to oligotrophic than eutrophic.

Internal Nutrient Loading

Internal nutrient loading is the recycling of nutrients, commonly phosphorus, from lake sediments. If a lake's nutrient-rich bottom sediments are exposed to anoxic (devoid of oxygen) conditions during stratification, the iron that normally holds the phosphorus in the sediments releases it into the hypolimnion (bottom water layer) of the lake. During turnover events, this nutrient-rich water is mixed with the other layers often spurring or maintaining algal blooms. Internal nutrient loading can be a significant source of phosphorus in lakes long after external sources have been minimized. Without data pertaining to hypolimnetic phosphorus values, the role that internal nutrient loading has on a lake's nutrient budget cannot be determined. Based on dissolved oxygen profiles collected by the LMA, Lake Metonga does strongly stratify during the summer and experience hypolimnetic anoxia; therefore, internal nutrient loading is likely occurring to some extent, but further studies would be required to determine its significance.

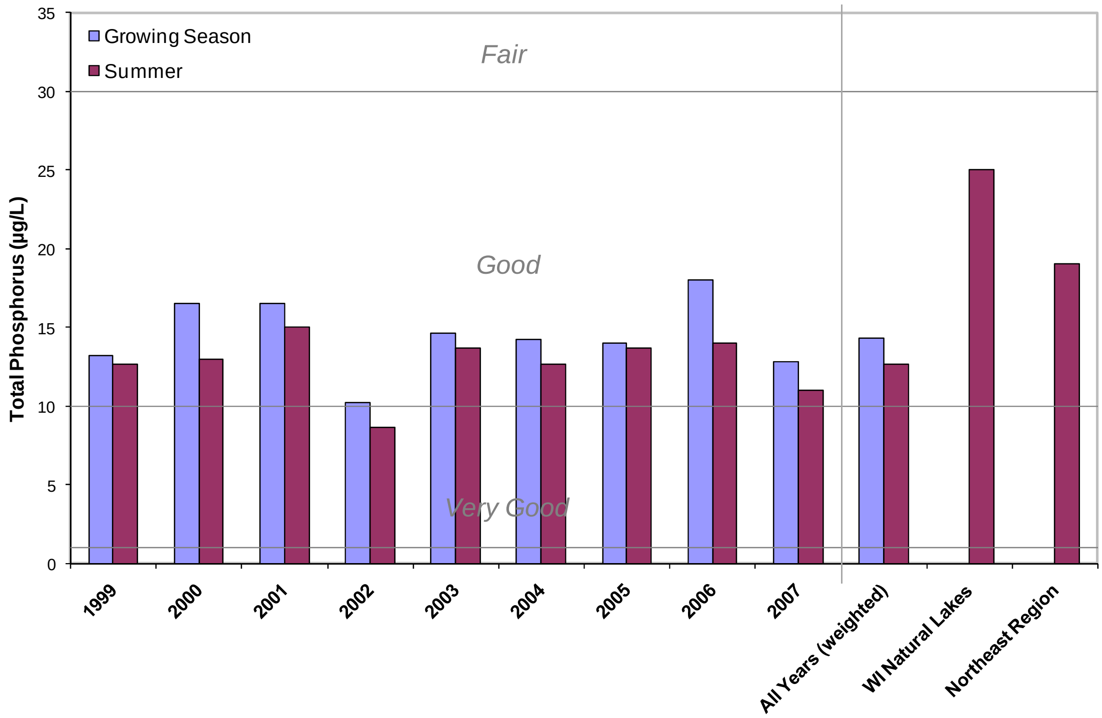

Figure 2. Lake Metonga total phosphorus concentrations. Mean values calculated with summer and growing season surface sample data. Water Quality Index values adapted from Lillie and Mason (1983).

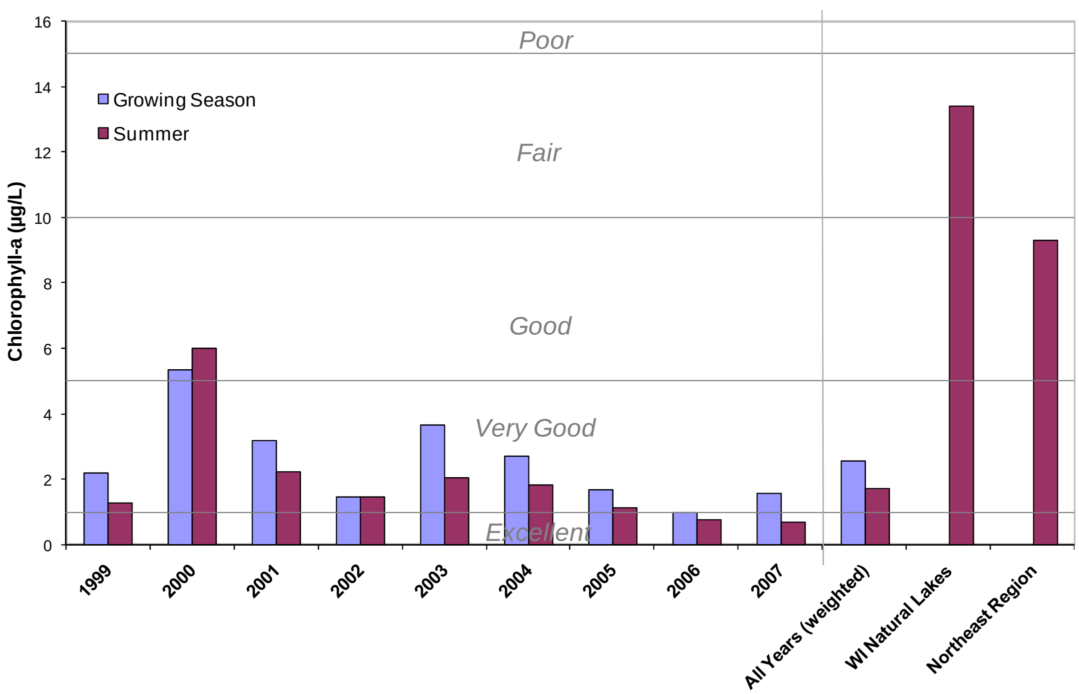

Figure 3. Lake Metonga chlorophyll-*a* concentrations. Mean values calculated with summer and growing season surface sample data. Water Quality Index values adapted from Lillie and Mason (1983).

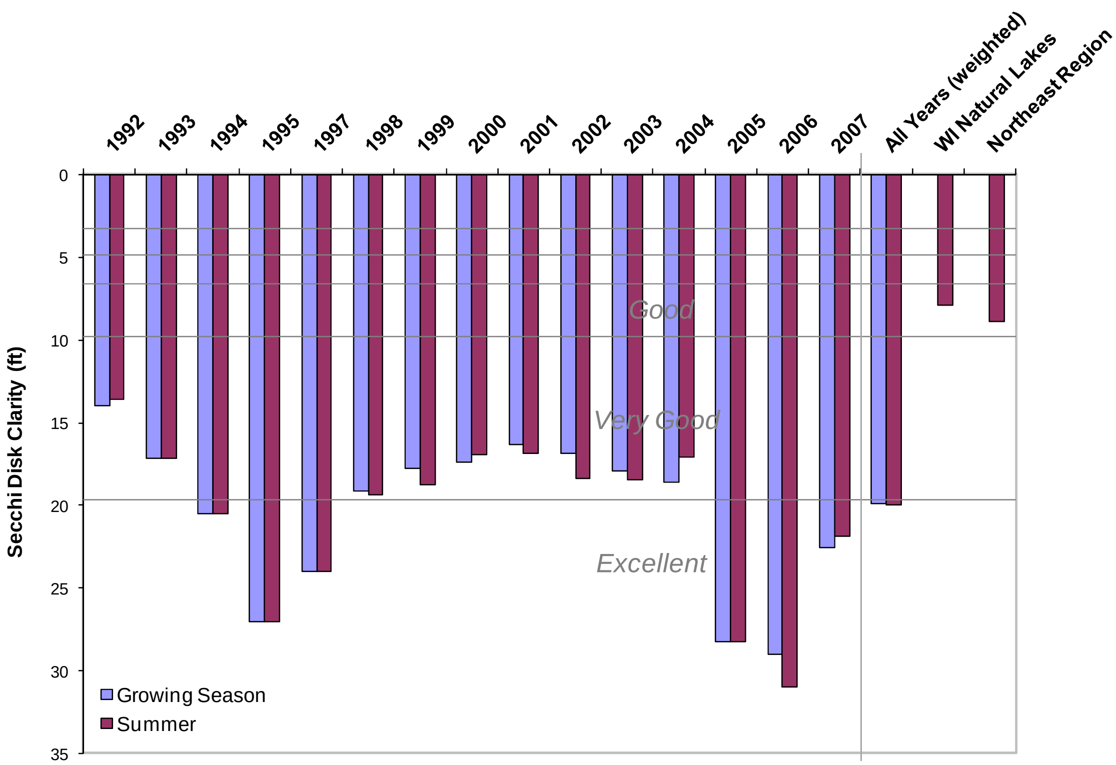

Figure 4. Lake Metonga Secchi disk transparency values. Mean values calculated with summer and growing season surface sample data. Water Quality Index values adapted from Lillie and Mason (1983).

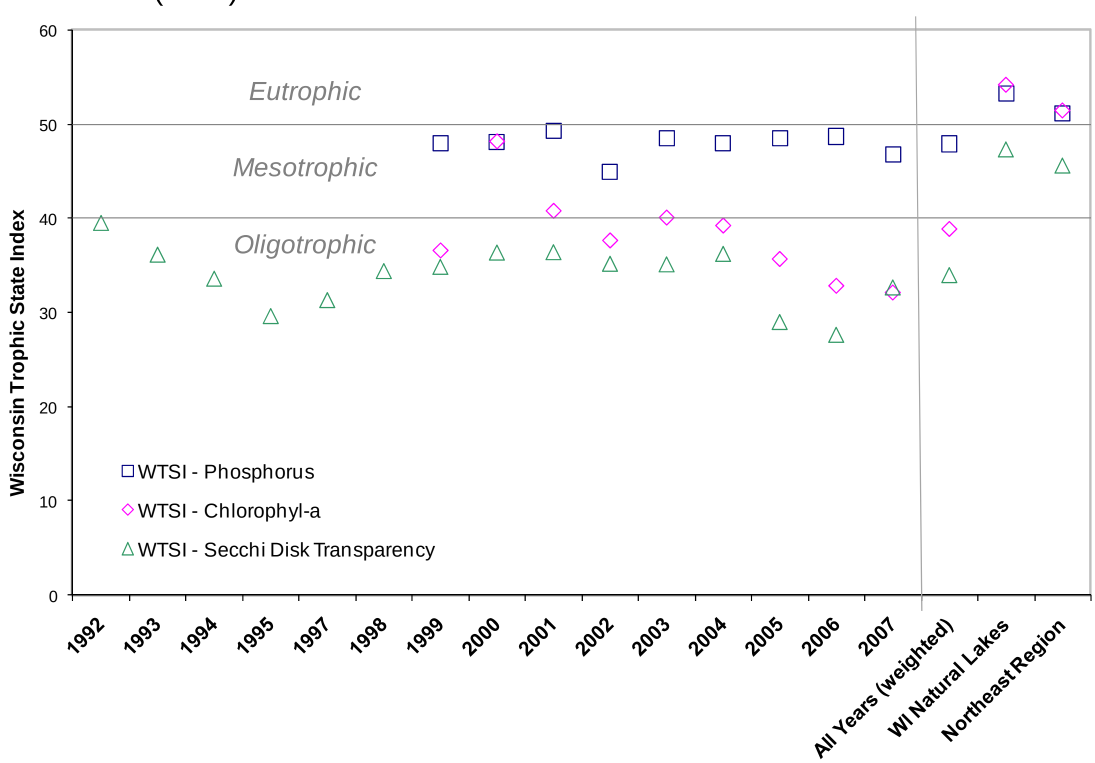

Figure 5. Lake Metonga Wisconsin Trophic State Index values. Values calculated with summer month surface sample data using Lillie et al. (1993).

Watershed Analysis

The Lake Metonga watershed is approximately 5,791 acres (Map 2). This yields a watershed to lake area ratio of approximately 2.9:1. This means that for every acre of lake there are 2.9 acres of watershed draining to it. In general, lakes with higher watershed to lake area ratios, those exceeding 10:1, tend to exhibit higher in-lake phosphorus levels. However, land use, or land cover, within the watershed is the primary factor controlling the amount of sediment and nutrients loaded to a lake. Heavily vegetated areas, such as forests and grasslands export the least amount of pollutants because the majority of the precipitation that falls on them penetrates the soil and enters the groundwater. This creates very little surface runoff to carry sediment and nutrients to the lake. Land uses with little vegetative cover, such as agricultural areas (especially row crops) and residential areas tend to allow much of the precipitation that falls on them to become surface runoff, while very little enters the groundwater. As the water moves over the surface of these land covers, it picks up sediment and nutrients which are eventually delivered to the lake.

Figure 6 summarizes the land cover data for the Lake Metonga watershed. Phosphorus load modeling using standard export coefficients contained in the Wisconsin Lake Modeling Suite (WiLMS, Appendix D) resulted in an annual load of approximately 1,457 lbs.

While almost three-fourths of a ton of phosphorus entering Lake Metonga may appear to be a great deal, it could be much more if the watershed was not in the condition it is in. Figure 7 displays the breakdown of the Lake phosphorus load based upon the different land covers found in the lake's watershed. Aside from the lake itself, the forested areas are the largest contributor to the Lake Metonga phosphorus load (21%), with pasture/grasslands providing a similar amount of phosphorus (20%).

Interestingly, although urban land cover (high and medium density) accounts for only 6 percent of the watershed acreage, WiLMS estimates that it contributes 19% of the lake's total phosphorus load. This means that if more of the watershed was used for this type of acreage, it would be expected that the total phosphorus load to Lake Metonga would be much greater, which in turn would result in greater plant production and sedimentation.

As mentioned above, Lake Metonga itself is actually the largest source of phosphorus loading through atmospheric phosphorus deposition. This source of phosphorus is obviously not able to be controlled. Although Lake Metonga's large surface area is the largest contributor to its phosphorus loading, its volume is probably its greatest asset in limiting these affects. Lake Metonga's 18 billion gallons (54,547 acre-feet) of water work to dilute the effects caused by access nutrients and pollutants.

Confounding these data is the fact that the City of Crandon, like most urban areas, has a storm sewer system designed to carry surface water away from the city. This underground network of interconnected pipes is able to extend a lake's watershed because it has the ability to carry water that would normally fall outside of the Lake Metonga watershed, into it. Also, the extension of the watershed is almost always urban land cover types, those that have high phosphorus loading coefficients. Actually, slightly more of the land area (53.9%) that makes up the City of Crandon is outside of the Lake Metonga watershed. However, these boundaries do not represent the extents of the storm sewer system. Only 75 acres (2.5%) of the surface area of the City of Crandon that is outside of the Lake Metonga watershed is either medium or high density urban, the types of land cover that would have the highest potential of containing a storm water system. Although, without knowing the extents and functions of the storm water system, there is no way to understand the effects that it may or may not have on Lake Metonga.

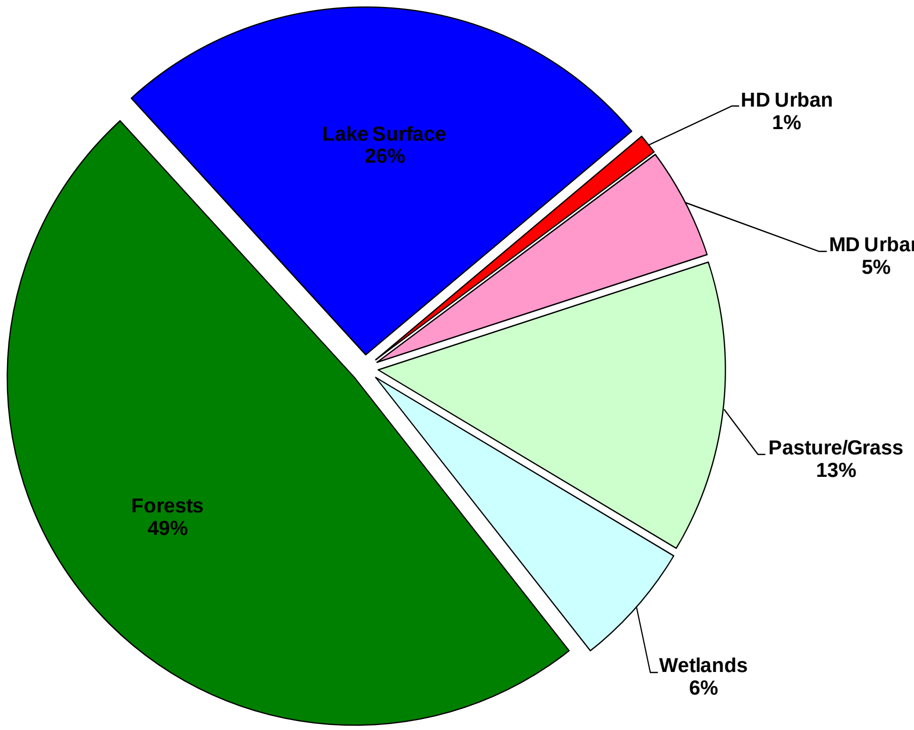

Figure 6. Lake Metonga watershed land cover types. Based upon Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data (WISCLAND) (WDNR 1998).

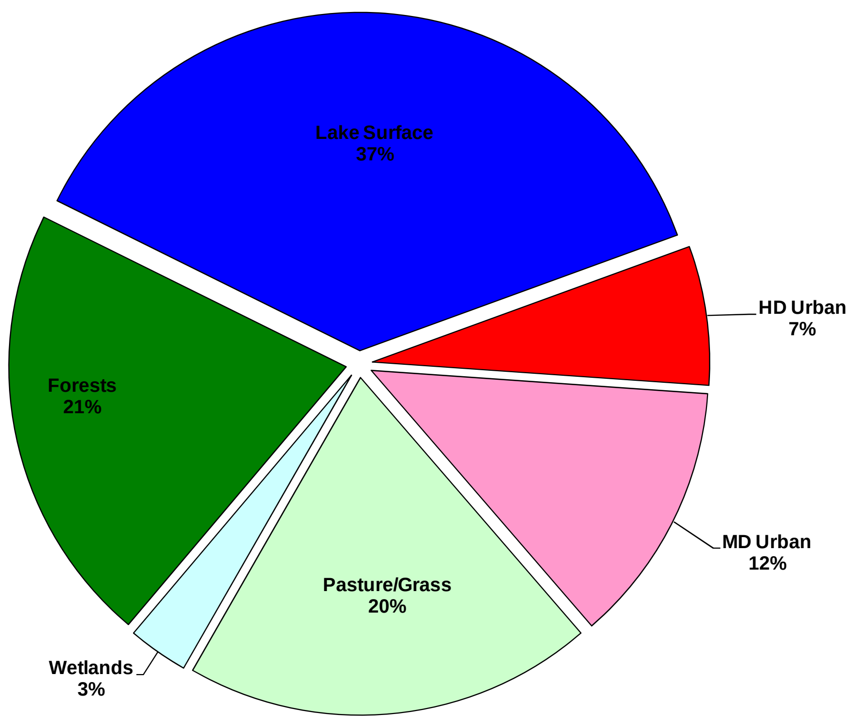

Figure 7. Lake Metonga watershed phosphorus loading in pounds. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

Lake Metonga Fishery

Fishery management is an important aspect in the comprehensive management of a lake ecosystem; therefore, a brief summary of available data is included here as reference. Although current fish data were not collected, the following information was compiled based upon data available from the WDNR and the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) WDNR 2007 & GLIFWC 2007). A summary report of activities completed in 2007 is provided in Appendix G, written by Mike Preul, Sokaogon Chippewa Community Fisheries Biologist.

Table 1. Gamefish present in Lake Metonga with corresponding biological information (Becker, 1983).

Common Name	Scientific Name	Max Age (yrs)	Spawning Period	Spawning Habitat Requirements	Food Source
Black Bullhead	*Ictalurus melas*	5	April - June	Matted vegetation, woody debris, overhangin banks	Amphipods, insect larvae and adults, fish, detritus, algae
Black Crappie	*Pomoxis nigromaculatus*	7	May - June	Near *Chara* or other vegetation, over sand or fine gravel	Fish, cladocera, insect larvae, other inverts
Bluegill	*Lepomis macrochirus*	11	Late May - Early August	Shallow water with sand or gravel bottom	Fish, crayfish, aquatic insects and other invertebrates
Largemouth Bass	*Micropterus salmoides*	13	Late April - Early July	Shallow, quiet bays with emergent vegetation	Fish, amphipods, algae, crayfish and other invertebrates
Northern Pike	*Esox lucius*	25	Late March - Early April	Shallow, flooded marshes with emergent vegetation with fine leaves	Fish including other pikes, crayfish, small mammals, water fowl, frogs
Pumpkinseed	*Lepomis gibbosus*	12	Early May - August	Shallow warm bays 0.3-0.8 m, with sand or gravel bottom	Crustaceans, rotifers, mollusks, flatworms, insect larvae (ter. and aq.)
Rock Bass	*Ambloplites rupestris*	13	Late May - Early June	Bottom of course sand or gravel, 1cm-1m deep	Crustaceans, insect larvae, and other inverts
Smallmouth Bass	*Micropterus dolomieu*	13	Mid May - June	Nests more common on North and West shorelines, over gravel	Small fish including other bass, crayfish, insects (aq. and ter)
Walleye	*Sander vitreus*	18	Mid April - early May	Rocky, wavewashed shallows,inlet streams on gravel bottoms	fish, fly and other insect larvae, crayfish
Yellow Perch	*Perca flavescens*	13	April - early May	Sheltered areas, emergent and submergent veg	Small fish, aquatic invertebrates

Based on data collected from the stakeholder survey (Appendix B), fishing was the activity most often ranked first as the most important or enjoyable on Lake Metonga. Over 90% of these same respondents believed that the quality of fishing on Lake Metonga was either fair or poor and approximately 92% believe that the quality of fishing has remained the same or gotten worse since they have obtained their property.

Table 1 shows the popular game fish that are present in the system. Management actions that have taken place and will likely continue on Lake Metonga according to this plan include herbicide applications to control EWM. These applications occur in May when the water temperatures are below 60°F. It is important to understand the effect the chemical has on the spawning environment which would be to remove broad-leaf (dicot) submergent plants that are actively growing at these low water temperatures. Black bullhead and yellow perch are two species that could be affected by early season herbicide applications. It is important to note that anecdotal reports from LMA members state that the populations of these two species are greatly on the rise, possibly attributed to the increase in the habitat provided by EWM.

Approximately 22,400 square miles of northern Wisconsin was ceded to the United States by the Lake Superior Chippewa tribes in 1837 and 1842 (Figure 8). Lake Metonga falls within the ceded territory based on the Treaty of 1842. This allows for a regulated spear fishery by Native Americans on specified systems. The spear harvest is regulated by having the six Wisconsin Chippewa Tribes declaring a tribal quota based on a percent of the estimated safe harvest each year by March 15. The tribal declaration will influence the daily bag limits for hook-and-line anglers, possibly reducing it to zero if 100% of the safe harvest is declared. The tribes have historically selected a percentage which allows for a 2-3 daily bag limit for hook-and-line anglers (USDI 2007).

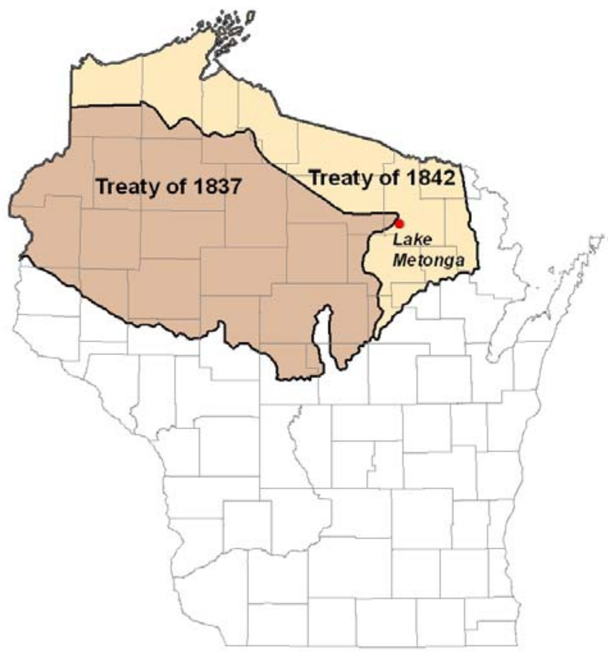

Figure 8. Location of Lake Metonga within the Native American Ceded Territory (GLIFWC 2007). This map was digitized by Onterra; therefore it is a representation and not legally binding.

The Sokaogon Chippewa (Mole Lake) tribe exercises their rights to spear on Lake Metonga. Spearers are able to harvest walleye, northern pike, and bass. Walleye harvest records are provided in Table 2. One common misconception noted from the stakeholder survey (Appendix B – Written Comments) is that the spear harvest targets the large spawning females. Table 2 clearly shows that the opposite is true with only 13.5% of the total walleye harvest since 1998 comprising female fish on Lake Metonga.

Spearers are also able to harvest northern pike and bass on Lake Metonga. Table 3 shows the fish that were harvested since 1998.

Table 2. Spear harvest data of walleye from *Lake Metonga* (Management Planning document, NLS 2002) and GLIFWC annual reports for Lake Metonga (Krueger 1998-2006).

Year	Total	% Quota	Mean Length* (inches)	% Male*	% Female*	% Unknown*
1985	80	n/a	n/a	n/a	n/a	n/a
1986	17	n/a	n/a	n/a	n/a	n/a
1987	488	n/a	n/a	n/a	n/a	n/a
1988	569	n/a	n/a	n/a	n/a	n/a
1989	0	n/a	n/a	n/a	n/a	n/a
1990	208	n/a	n/a	n/a	n/a	n/a
1991	184	n/a	n/a	n/a	n/a	n/a
1992	441	n/a	n/a	n/a	n/a	n/a
1993	365	n/a	n/a	n/a	n/a	n/a
1994	313	n/a	n/a	n/a	n/a	n/a
1995	472	n/a	n/a	n/a	n/a	n/a
1996	681	n/a	n/a	n/a	n/a	n/a
1997	443	n/a	n/a	n/a	n/a	n/a
1998	695	100.0	15.3	88.8	7.6	3.6
1999	461	99.4	15.0	80.7	13.4	5.9
2000	457	100.0	15.9	75.5	22.1	2.4
2001	305	100.0	16.5	67.9	24.6	7.5
2002	323	97.6	17.1	72.8	22.6	4.6
2003	206	93.2	16.4	78.2	8.7	13.1
2004	177	100.0	16.9	81.9	10.7	7.3
2005	87	98.9	15.4	86.2	6.9	6.9
2006	97	100.0	14.6	92.8	5.2	2.1

*Based on Measured Fish

Table 3. Spear harvest data of non-walleye gamefish from GLIFWC annual reports for Lake Metonga (Krueger 1998-2006).

Year	Species	Total	Mean Length* (inches)
1998	Northern Pike	2	39
1998	Smallmouth Bass	1	15
2000	Northern Pike	1	25.8
2001	Northern Pike	1	24.4
2001	Smallmouth Bass	1	15.9
2003	Northern Pike	1	n/a
2003	Bass	1	16.0

*Based on Measured Fish

Table 4. Fish stocking data available from the WDNR from 1972 to 2006 (WDNR 2007) and *Supplemental Information: Fisheries* (LMA 2002a).

Year	Species	Age Class	# Fish Stocked
1937	Walleye	Yearling	55
1937	Walleye	Fry	4,989,030
1937	Large Mouth Bass	Fingerling	100
1937	Crappie	Adult	464
1937	Sunfish	Adult	1,000
1937	Bluegill	Adult	7,020
1937	Bluegill	Fingerling	13,300
1937	Yellow Perch	Fingerling	54,100
1938	Walleye	Fry	1,054,950
1938	Bluegill	Fingerling	5,000
1938	Yellow Perch	Adult	300
1938	Yellow Perch	Fingerling	25,000
1939	Yellow Perch	Fingerling	25,000
1939	Walleye	Fry	2,000,000
1940	Bluegill	Adult	100
1940	Bluegill	Fingerling	1,150
1940	Walleye	Fry	2,250,000
1941	Yellow Perch	Fingerling	25,000
1941	Walleye	Fry	2,250,000
1942	Northern Pike	Fry	30,000
1942	Walleye	Fry	3,200,000
1943	Large Mouth Bass	Fingerling	8,840
1943	Walleye	Fingerling	3,600
1943	Walleye	Fry	2,550,000
1944	Large Mouth Bass	Fingerling	1,904
1944	Walleye	Fry	1,400,000
1945	Large Mouth Bass	Fingerling	11,199
1945	Walleye	Fingerling	16,000
1946	Walleye	Fingerling	12,000
1946	Walleye	Fry	2,000,000
1947	Large Mouth Bass	Fingerling	20,000
1948	Walleye	Fingerling	21
1950	Walleye	Fingerling	11,200
1950	Northern Pike	Fry	700,000
1950	Large Mouth Bass	Fingerling	10,000
1952	Large Mouth Bass	Fingerling	7,025
1953	Walleye	Fingerling	10,500
1954	Walleye	Fingerling	2,500
1955	Walleye	Fingerling	9,530
1978	Walleye	Fingerling	3,750
1979	Walleye	3 Inch	26,000
1979	Walleye	3 Inch	76,376
1980	Walleye	Fingerling	40,185
1980	Walleye	Fingerling	10,520
1981	Walleye	Fingerling	71,760
1982	Walleye	3 Inch	100,000
1983	Walleye	3 Inch	64,800

Year	Species	Age Class	# Fish Stocked
1984	Walleye	Fingerling	41,000
1986	Walleye	Fingerling	38,805
1991	Walleye	Fingerling	55,135
1992	Walleye	Fingerling	55,448
1994	Walleye	Fingerling	105,098
1997	Walleye	Fingerling	100,000
1999	Walleye	Fry	157,000
2000	Walleye	Fingerling	198,147
2000	Walleye	Fingerling	100,947
2000	Walleye	Fingerling	97,200
2000	Walleye	Fry	165,000
2007	Walleye	6-9 Inch	5,000

Walleye is prized game fish in northern Wisconsin and can be found in Lake Metonga. As stated above, Lake Metonga is located within ceded territory and special fisheries regulations occur, specifically in terms of walleye. An adjusted walleye bag limit pamphlet is distributed each year by the WDNR which explains the more restrictive bag or length limits that may pertain to Lake Metonga. Motor trolling is permitted on Lake Metonga.

Walleye have been actively stocked in recent years by the WDNR (Table 4) in an effort to influence the populations of these species. Current walleye population estimates are approximately 0.8 fish per acre, well below the management goals of 2 fish per acre (Appendix G). Historically, other species have been stocked in Lake Metonga including largemouth bass, yellow perch, bluegill, sunfish, crappie and northern pike (Table 4). Largemouth bass populations are quite low in Lake Metonga, attributed to lack of preferred habitat and competition from other species (Appendix G). The population of northern pike has been in great decline, possibly related to increases in invasive species and loss of habitat (Appendix G).

Aquatic Plants and the Lake Ecosystem

Although some lake users consider aquatic macrophytes to be “weeds” and a nuisance to the recreational use of the lake, they are actually an essential element in a healthy and functioning lake ecosystem. It is very important that the lake stakeholders understand the importance of lake plants and the many functions they serve in maintaining and protecting a lake ecosystem. With increased understanding and awareness, most lake users will recognize the importance of the aquatic plant community and their potential negative affects on it.

Diverse aquatic vegetation provides habitat and food for many kinds of aquatic life, including fish, insects, amphibians, waterfowl, and even terrestrial wildlife. For instance, wild celery (*Vallisneria americana)* and wild rice (*Zizania aquatica* and *Z. palustris*) both serve as excellent food sources for ducks and geese. Emergent stands of vegetation provide necessary spawning habitat for fish such as northern pike (*Esox lucius*) and yellow perch (*Perca flavescens*) In addition, many of the insects that are eaten by young fish rely heavily on aquatic plants and the *periphyton* attached to them as their primary food source. The plants also provide cover for feeder fish and *zooplankton*, stabilizing the predator-prey relationships within the system.

Furthermore, rooted aquatic plants prevent shoreline erosion and the resuspension of sediments and nutrients by absorbing wave energy and locking sediments within their root masses. In areas where plants do not exist, waves can resuspend bottom sediments decreasing water clarity and increasing plant nutrient levels that may lead to algae blooms. Lake plants also produce oxygen through photosynthesis and use nutrients that may otherwise be used by *phytoplankton*, which helps to minimize nuisance algal blooms.

Under certain conditions, a few species may become a problem and require control measures. Excessive plant growth can limit recreational use by deterring navigation, swimming, and fishing activities. It can also lead to changes in fish population structure by providing too much cover for feeder fish resulting in reduced numbers of predator fish and a stunted pan-fish population. *Exotic* plant species, such as Eurasian water-milfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*) can also upset the delicate balance of a lake ecosystem by out competing *native* plants and reducing *species diversity*. These *invasive* plant species can form dense stands that are a nuisance to humans and provide low-value habitat for fish and other wildlife.

When plant abundance negatively affects the lake ecosystem and limits the use of the resource, plant management and control may be necessary. The management goals should always include the control of invasive species and restoration of native communities through environmentally sensitive and economically feasible methods. No aquatic plant management plan should only contain methods to control plants, they should also contain methods on how to protect and possibly enhance the important plant communities within the lake. Unfortunately, the latter is often neglected and the ecosystem suffers as a result.

Introduction to Aquatic Plant Management and Protection

Many times an aquatic plant management plan is aimed at only controlling nuisance plant growth that has limited the recreational use of the lake, usually navigation, fishing, and swimming. It is important to remember the vital benefits that native aquatic plants provide to lake users and the lake ecosystem, as described above. Therefore, all aquatic plant management plans also need to address the enhancement and protection of the aquatic plant community. Below are general descriptions of the many techniques that can be utilized to control and enhance aquatic plants. Each alternative has benefits and limitations that are explained in its description. Please note that only legal and commonly used methods are included. For instance, the herbivorous grass carp (*Ctenopharyngodon idella*) is illegal in Wisconsin and rotovation, a process by which the lake bottom is tilled, is not a commonly accepted practice. Unfortunately, there are no "silver bullets" that can completely cure all aquatic plant problems, which makes planning a crucial step in any aquatic plant management activity. Many of the plant management and protection techniques commonly used in Wisconsin are described below.

Please note: Even though all of these techniques may not be applicable to Lake Metonga, it is still important for lake users to have a basic understanding of all the techniques so they can better understand why particular methods are or are not applicable in their lake**.** The techniques applicable to Lake Metonga are located in the management section.

Permits

The signing of the 2001-2003 State Budget by Gov. McCallum enacted many aquatic plant management regulations. The rules for the regulations have been set forth by the WDNR as NR 107 and 109. A major change includes that all forms of aquatic plant management, even those that did not require a permit in the past, require a permit now, including manual and mechanical removal. Manual cutting and raking are exempt from the permit requirement if the area of plant removal is no more than 30 feet wide and any piers, boatlifts, swim rafts, and other recreational and water use devices are located within that length. Furthermore, installation of aquatic plants, even natives, requires approval from the WDNR. It is important to note that local permits and U.S. Army Corps of Engineers regulations may also apply. For more information on permit requirements, please contact the WDNR Regional Water Management Specialist or Aquatic Plant Management and Protection Specialist.

Native Species Enhancement

The development of Wisconsin's shorelands has increased dramatically over the last century and with this increase in development a decrease in water quality and wildlife habitat has occurred. Many people that move to or build in shoreland areas attempt to replicate the suburban landscapes they are accustomed to by converting natural shoreland areas to the "neat and clean" appearance of manicured lawns and flowerbeds. The conversion of these areas immediately leads to destruction of habitat utilized by birds, mammals, reptiles, amphibians, and insects. The maintenance of the newly created area helps to decrease water quality by considerably increasing inputs of phosphorus and sediments into the lake. The negative impact of human development does not stop at the shoreline. Removal of native plants and dead, fallen timbers from shallow, near-shore areas for boating and swimming activities destroys habitat used by fish, mammals, birds, insects, and amphibians, while leaving bottom and shoreline sediments vulnerable to wave action caused by boating and wind. Many homeowners significantly decrease the number of trees and shrubs along the water's edge in an effort to increase their view of the lake. However, this has been shown to locally increase water temperatures, and decrease infiltration rates of potentially harmful nutrients and pollutants. Furthermore, the dumping of sand to create beach areas destroys spawning, cover and feeding areas utilized by aquatic wildlife.

In recent years, many lakefront property owners have realized increased aesthetics, fisheries, property values, and water quality by restoring portions of their shoreland to mimic its unaltered state. An area of shore restored to its natural condition, both in the water and on shore, is commonly called a *shoreland buffer zone.* The shoreland buffer zone creates or restores the ecological habitat and benefits lost by traditional suburban landscaping. Simply not mowing within the buffer zone does wonders to restore some of the shoreland's natural function.

Enhancement activities also include additions of *submergent*, *emergent*, and *floating-leaf* plants within the lake itself. These additions can provide greater species diversity and may compete against exotic species.

Cost

The cost of native, aquatic and shoreland plant restorations is highly variable and depend on the size of the restoration area, planting densities, the species planted, and the type of planting (e.g. seeds, bare-roots, plugs, live-stakes) being conducted. Other factors may include extensive grading requirements, removal of shoreland stabilization (e.g., rip-rap, seawall), and protective measures used to guard the newly planted area from wildlife predation, wave-action, and erosion. In general, a restoration project with the characteristics described below would have an estimated materials and supplies cost of approximately $4,200.

- The single site used for the estimate indicated above has the following characteristics:
  - An upland buffer zone measuring 35' x 100'.
  - An aquatic zone with shallow-water and deep-water areas of 10' x 100' each.
  - Site is assumed to need little invasive species removal prior to restoration.
  - Site has a moderate slope.
  - Trees and shrubs would be planted at a density of 435 plants/acre and 1210 plants/acre, respectively.
  - Plant spacing for the aquatic zone would be 3 feet.
  - Each site would need 100' of biolog to protect the bank toe and each site would need 100' of wavebreak and goose netting to protect aquatic plantings.
  - Each site would need 100' of erosion control fabric to protect plants and sediment near the shoreline (the remainder of the site would be mulched).
  - There is no hard-armor (rip-rap or seawall) that would need to be removed.
  - The property owner would maintain the site for weed control and watering.

Advantages

Improves the aquatic ecosystem through species diversification and habitat enhancement.
Assists native plant populations to compete with exotic species.
Increases natural aesthetics sought by many lake users.
Decreases sediment and nutrient loads entering the lake from developed properties.
Reduces bottom sediment resuspension and shoreline erosion.
Lower cost when compared to rip-rap and seawalls.
Restoration projects can be completed in phases to spread out costs.
Many educational and volunteer opportunities are available with each project.

Disadvantages

Property owners need to be educated on the benefits of native plant restoration before they are willing to participate.
Stakeholders must be willing to wait 3-4 years for restoration areas to mature and fill-in.
Monitoring and maintenance are required to assure that newly planted areas will thrive.
Harsh environmental conditions (e.g., drought, intense storms) may partially or completely destroy project plantings before they become well established.

Manual Removal

Manual removal methods include hand-pulling, raking, and hand-cutting. Hand-pulling involves the manual removal of whole plants, including roots, from the area of concern and disposing them out of the waterbody. Raking entails the removal of partial and whole plants from the lake by dragging a rake with a rope tied to it through plant beds. Specially designed rakes are available from commercial sources or an asphalt rake can be used. Hand-cutting differs from the other two manual methods because the entire plant is not removed, rather the plants are cut similar to mowing a lawn; however Wisconsin law states that all plant fragments must be removed. One manual cutting technique involves throwing a specialized "V" shaped cutter into the plant bed and retrieving it with a rope. The raking method entails the use of a two-sided straight blade on a telescoping pole that is swiped back and forth at the base of the undesired plants.

In addition to the hand-cutting methods described above, powered cutters are now available for mounting on boats. Some are mounted in a similar fashion to electric trolling motors and offer a 4-foot cutting width, while larger models require complicated mounting procedures, but offer an 8-foot cutting width.

When using the methods outlined above, it is very important to remove all plant fragments from the lake to prevent re-rooting and drifting onshore followed by decomposition. It is also important to preserve fish spawning habitat by timing the treatment activities after spawning. In Wisconsin, a general rule would be to not start these activities until after June 15th.

Cost

Commercially available hand-cutters and rakes range in cost from $85 to $150. Power-cutters range in cost from $1200 to $11,000.

Advantages

Very cost effective for clearing areas around docks, piers, and swimming areas.
Relatively environmentally safe if treatment is conducted after June 15th.
Allows for selective removal of undesirable plant species.
Provides immediate relief in localized area.
Plant biomass is removed from waterbody.

Disadvantages

Labor intensive.
Impractical for larger areas or dense plant beds.
Subsequent treatments may be needed as plants recolonize and/or continue to grow.
Uprooting of plants stirs bottom sediments making it difficult to harvest remaining plants
May disturb *benthic* organisms and fish-spawning areas.
Risk of spreading invasive species if fragments are not removed.

Bottom Screens

Bottom screens are very much like landscaping fabric used to block weed growth in flowerbeds. The gas-permeable screen is placed over the plant bed and anchored to the lake bottom by staking or weights. Only gas-permeable screen can be used or large pockets of gas will form under the mat as the result of plant decomposition. This could lead to portions of the screen becoming detached from the lake bottom, creating a navigational hazard. Normally the screens are removed and cleaned at the end of the growing season and then placed back in the lake the following spring. If they are not removed, sediments may build up on them and allow for plant colonization on top of the screen.

Cost

Material costs range between $.20 and $1.25 per square-foot. Installation cost can vary largely, but may roughly cost $750 to have 1,000 square feet of bottom screen installed. Maintenance costs can also vary, but an estimate for a waterfront lot are about $120 each year.

Advantages

Immediate and sustainable control.
Long-term costs are low.
Excellent for small areas and around obstructions.
Materials are reusable.
Prevents fragmentation and subsequent spread of plants to other areas.

Disadvantages

Installation may be difficult over dense plant beds and in deep water.
Not species specific.
Disrupts benthic fauna.
May be navigational hazard in shallow water.
Initial costs are high.
Labor intensive due to the seasonal removal and reinstallation requirements.
Does not remove plant biomass from lake.
Not practical in large-scale situations.

Water Level Drawdown

The primary manner of plant control through water level drawdown is the exposure of sediments and plant roots/tubers to desiccation and either heating or freezing depending on the timing of the treatment. Winter drawdowns are more common in temperate climates like that of Wisconsin and usually occur in reservoirs because of the ease of water removal through the outlet structure. An important fact to remember when considering the use of this technique is that only certain species are controlled and that some species may even be enhanced. Furthermore, the process will likely need to be repeated every two or three years to keep target species in check.

Cost

The cost of this alternative is highly variable. If an outlet structure exists, the cost of lowering the water level would be minimal; however, if there is not an outlet, the cost of pumping water to the desirable level could be very expensive.

Advantages

Inexpensive if outlet structure exists.
May control populations of certain species, like Eurasian water-milfoil for up to two years.
Allows some loose sediments to consolidate.
May enhance growth of desirable emergent species.
Other work, like dock and pier repair may be completed more easily and at a lower cost while water levels are down.

Disadvantages

May be cost prohibitive if pumping is required to lower water levels.
Has the potential to upset the lake ecosystem and have significant affects on fish and other aquatic wildlife.
Adjacent wetlands may be altered due to lower water levels.
Disrupts recreational, hydroelectric, irrigation and water supply uses.
May enhance the spread of certain undesirable species, like common reed (*Phragmites australis*) and reed canary grass (*Phalaris arundinacea*).
Permitting process requires an environmental assessment that may take months to prepare.
Unselective.

Harvesting

Aquatic plant harvesting is frequently used in Wisconsin and involves the cutting and removal of plants much like mowing and bagging a lawn. Harvesters are produced in many sizes that can cut to depths ranging from 3 to 6 feet with cutting widths of 4 to 10 feet. Plant harvesting speeds vary with the size of the harvester, density and types of plants, and the distance to the off-loading area. Equipment requirements do not end with the harvester. In addition to the harvester, a shore-conveyor would be required to transfer plant material from the harvester to a dump truck for transport to a landfill or compost site. Furthermore, if off-loading sites are limited and/or the lake is large, a transport barge may be needed to move the harvested plants from the harvester to the shore in order to cut back on the time that the harvester spends traveling to the shore conveyor.

Some lake organizations contract to have nuisance plants harvested, while others choose to purchase their own equipment. If the latter route is chosen, it is especially important for the lake group to be very organized and realize that there is a great deal of work and expense involved with the purchase, operation, maintenance, and storage of an aquatic plant harvester. In either case, planning is very important to minimize environmental effects and maximize benefits.

Costs

Equipment costs vary with the size and features of the harvester, but in general, standard harvesters range between $45,000 and $100,000. Larger harvesters or stainless steel models may cost as much as $200,000. Shore conveyors cost approximately $20,000 and trailers range from $7,000 to $20,000. Storage, maintenance, insurance, and operator salaries vary greatly.

Advantages

Immediate results.
Plant biomass and associated nutrients are removed from the lake.
Select areas can be treated, leaving sensitive areas intact.
Plants are not completely removed and can still provide some habitat benefits.
Opening of cruise lanes can increase predator pressure and reduce stunted fish populations.
Removal of plant biomass can improve the oxygen balance in the littoral zone.
Harvested plant materials produce excellent compost.

Disadvantages

Initial costs and maintenance are high if the lake organization intends to own and operate the equipment.
Multiple treatments may be required during the growing season because lower portions of the plant and root systems are left intact.
Many small fish, amphibians and invertebrates may be harvested along with plants.
There is little or no reduction in plant density with harvesting.
Invasive and exotic species may spread because of plant fragmentation associated with harvester operation.
Larger harvesters are not easily maneuverable in shallow water or near docks and piers.
Bottom sediments may be resuspended leading to increased turbidity and water column nutrient levels.

Chemical Treatment

There are many herbicides available for controlling aquatic macrophytes and each compound is sold under many brand names. Aquatic herbicides fall into two general classifications:

1. *Contact herbicides* act by causing extensive cellular damage, but usually do not affect the areas that were not in contact with the chemical. This allows them to work much faster, but does not result in a sustained effect because the root crowns, roots, or rhizomes are not killed.
2. *Systemic herbicides* spread throughout the entire plant and often result in complete mortality if applied at the right time of the year.

Both types are commonly used throughout Wisconsin with varying degrees of success. The use of herbicides is potentially hazardous to both the applicator and the environment, so all lake organizations should seek consultation and/or services from professional applicators with training and experience in aquatic herbicide use.

Below are brief descriptions of the aquatic herbicides currently registered for use in Wisconsin.

<u>Fluridone</u> (Sonar®, Avast!®) Broad spectrum, systemic herbicide that is effective on most submersed and emergent macrophytes. It is also effective on duckweed and at low concentrations has been shown to selectively remove Eurasian water-milfoil. Fluridone slowly kills macrophytes over a 30-90 day period and is only applicable in whole lake treatments or in bays and backwaters were dilution can be controlled. Required length of contact time makes this chemical inapplicable for use in flowages and impoundments. Irrigation restrictions apply.

<u>Glyphosate</u> (Rodeo®) Broad spectrum, systemic herbicide used in conjunction with a *surfactant* to control emergent and floating-leaved macrophytes. It acts in 7-10 days and is not used for submergent species This chemical is commonly used for controlling purple loosestrife (*Lythrum salicaria*).. Glyphosate is also marketed under the name Roundup®; this formulation is not permitted for use near aquatic environments because of its harmful effects on fish, amphibians, and other aquatic organisms.

<u>Diquat</u> (Reward®, Weedtrine-D®) Broad spectrum, contact herbicide that is effective on all aquatic plants and can be sprayed directly on foliage (with surfactant) or injected in the water. It is very fast acting, requiring only 12-36 hours of exposure time. Diquat readily binds with clay particles, so it is not appropriate for use in turbid waters. Consumption restrictions apply.

<u>Endothal</u> (Hydrothol®, Aquathol®) Broad spectrum, contact herbicides used for spot treatments of submersed plants. The mono-salt form of Endothal (Hydrothol®) is more toxic to fish and aquatic invertebrates, so the dipotassium salt (Aquathol®) is most often used. Fish consumption, drinking, and irrigation restrictions apply.

<u>2,4-D</u> (Navigate®, Aqua-Kleen®, etc.) Selective, systemic herbicide that only works on broad-leaf plants. The selectivity of 2,4-D towards broad-leaved plants (dicots) allows it to be used for Eurasian water-milfoil without affecting many of our native plants, which are monocots. Drinking and irrigation restrictions apply.

Advantages

Herbicides are easily applied in restricted areas, like around docks and boatlifts.
If certain chemicals are applied at the correct dosages and at the right time of year, they can selectively control certain invasive species, such as Eurasian water-milfoil.
Some herbicides can be used effectively in spot treatments.

Disadvantages

Fast-acting herbicides may cause fishkills due to rapid plant decomposition if not applied correctly.
Many people adamantly object to the use of herbicides in the aquatic environment; therefore, all stakeholders should be included in the decision to use them.
Many herbicides are nonselective.
Most herbicides have a combination of use restrictions that must be followed after their application.
Many herbicides are slow-acting and may require multiple treatments throughout the growing season.

Cost

Herbicide application charges vary greatly between $400 to $1000 per acre depending on the chemical used, who applies it, permitting procedures, and the size of the treatment area.

Biological Controls

There are many insects, fish and pathogens within the United States that are used as biological controls for aquatic macrophytes. For instance, the herbivorous grass carp has been used for years in many states to control aquatic plants with some success and some failures. However, it is illegal to possess grass carp within Wisconsin because their use can create problems worse than the plants that they were used to control. Other states have also used insects to battle invasive plants, such as water hyacinth weevils (*Neochetina spp.*) and hydrilla stem weevil (*Bagous spp.*) to control water hyacinth (*Eichhornia crassipes*) and hydrilla (*Hydrilla verticillata)*, respectively. Fortunately, it is assumed that Wisconsin’s climate is a bit harsh for these two invasive plants, so there is not need for either biocontrol insect. However, Wisconsin, along with many other states, is currently experiencing the expansion of lakes infested with Eurasian water-milfoil and as a result has supported the experimentation and use of the milfoil weevil (*Euhrychiopsis lecontei*) within its lakes. The milfoil weevil is a native weevil that has shown promise in reducing Eurasian water-milfoil stands in Wisconsin, Washington, Vermont, and other states. Research is currently being conducted to discover the best situations for the use of the insect in battling Eurasian water-milfoil. Wisconsin is also using two species of leaf-eating beetles (*Galerucella calmariensis* and *G. pusilla*) to battle purple loosestrife. These biocontrol insects are not covered here because purple loosestrife is predominantly a wetland species.

Advantages

Milfoil weevils occur naturally in Wisconsin.
This is likely an environmentally safe alternative for controlling Eurasian water-milfoil.

Disadvantages

Stocking and monitoring costs are high.
This is an unproven and experimental treatment.
There is a chance that a large amount of money could be spent with little or no change in Eurasian water-milfoil density.

Cost

Stocking with adult weevils costs about $1.20/weevil and they are usually stocked in lots of 1000 or more.

History of Aquatic Invasive Species in Lake Metonga

The first invader of Lake Metonga was in the 1960's when rusty crayfish most likely entered through angler's disregarded bait. These crayfish flourished in the 1970's and early 1980's, decimating the lake's plant population and displacing the region's two native crayfish, the northern crayfish (*Orconectes virilis*) and the northern clear water crayfish (*O. propinquus*). Anecdotal evidence suggests that through extensive harvesting and natural fish predation, the rusty crayfish in Lake Metonga are not currently impacting the lake in the same manner as they once did (LMA 2002b, NLS 2002)

Eurasian water milfoil was first discovered by Northern Lake Service, Inc. in 1997 when they were conducting a study on Lake Metonga. In 1998, a chemical treatment with 2,4-D was conducted on 1.6 acres. An additional 0.5 acres was then treated in 1999. In 2000, it appeared that the Eurasian water milfoil in these areas was under control and no chemical treatment was conducted. However, in 2001, 3.3 acres were treated in the spring and 2.4 acres of this same acreage was treated again in fall. Four acres was treated again in 2002 and although exact acreages are not available, small treatments were conducted in 2003 and 2004 (LMA 2002b, NLS 2002). The level of success achieved from these treatments is not fully understood; however in the 2004 treatment permit application it is stated that only minimal success was achieved in 2002 and 2003.

In 2002, the LMA contracted EnviroScience, Inc. to release 8,000 native weevils into Lake Metonga to help control the Eurasian water milfoil. Although preliminary reports provided by EnviroScience, Inc. and the WDNR reported that weevil populations were healthy, there was no documentation of Eurasian water milfoil control on a site-wide basis (LMA 2002b). Furthermore, anecdotal reports from Les Schramm and members of the LMA state that there was no control of Eurasian water milfoil by the weevils. The lack of over wintering conditions and predation most likely has contributed to the failures of this management action. The following sections elaborate in detail on the amount of Eurasian water milfoil in Lake Metonga, the management of Eurasian water milfoil in Lake Metonga, and the success of the management actions since 2005.

In July of 2001, WDNR staff visited Lake Metonga to gather Eurasian water milfoil specimens to use as presentation materials. Upon examining a few of the specimens, a few adult zebra mussels were discovered (LMA 2002b, NLS 2002). Since then, the LMA has been involved with the WDNR and the Sokaogon Chippewa Community (Mole Lake) in monitoring the adult and juvenile (veliger) zebra mussel populations in Lake Metonga. Zebra mussel densities have greatly increased and this mollusk can currently be located in almost every area on Lake Metonga. The affects that they pose on the ecosystem are unknown, but understudy by the Mole Lake tribal ecologists.

Aquatic Invasive Species Grant Report

The text that comprises the following sections, up until the 2006 Eurasian water milfoil treatment conclusions, can also be found in the final report written as a part of a Wisconsin Department of Natural Resources Aquatic Invasive Species Grant (ACEI-001-05). The Lake Metonga Association contracted with Onterra after the group successfully applied for a WDNR AIS grant. The project scope had two main components; one focusing on invasive aquatic plants and the other on native aquatic plants. Onterra was contracted to perform a pretreatment Eurasian water milfoil survey to help the LMA develop a chemical treatment strategy (2005) and follow up with two post treatment surveys (August 2005 and late spring 2006). When the LMA decided to treat again in 2006, a pretreatment survey and two post treatment surveys were added to better understand the Eurasian water milfoil in the lake. The original project scope included a comprehensive plant survey which consisted of a curly-leaf pondweed (CLP) survey, a point-intercept survey (150-meter resolution, 156 points), and a community mapping survey. The original 150-meter resolution (156 points) of the point-intercept survey from the project scope was changed due to new guidance from the WDNR to an 80-meter resolution (1311 points).

Analysis of Aquatic Plant Data

Aquatic plants are an important element in every healthy lake. Changes in lake ecosystems are often first seen in the lake's plant community. Whether these changes are positive, like variable water levels or negative, like increased shoreland development or the introduction of an exotic species, the plant community will respond. Plant communities respond in a variety of ways; there may be a loss of one or more species, certain life forms, such as emergents or floating-leaf communities may disappear from certain areas of the lake, or there may be a shift in plant dominance between species. With periodic monitoring and proper analysis, these changes are detectable and provide critical information for management decisions.

As described in more detail in the methods section, two aquatic plant surveys were completed on Lake Metonga. The first appeared strictly for curly-leaf pondweed, and the second inventoried all aquatic species found in the lake. Combined, these surveys produce a great deal of information about the aquatic vegetation of the lake. These data are analyzed and presented in numerous ways; each is discussed in more detail below.

Primer on Data Analysis & Data Interpretation

Species List

The species list is simply a list of all of the species that were found within the lake, both exotic and native. The list also contains the life-form of each plant found, its scientific name, and its coefficient of conservatism. The latter is discussed in more detail below. Changes in this list over time, whether it is differences in total species present, gains and losses of individual species, or changes in life-forms that are present, can be an early indicator of changes in the health of the lake ecosystem.

Ecoregions are areas related by similar climate, physiography, hydrology, vegetation and wildlife potential. Comparing ecosystems in the same ecoregion is sounder than comparing systems within manmade boundaries such as counties, towns, or states.

Frequency of Occurrence

Frequency of occurrence describes how often a certain species is found within a lake. Obviously, all of the plants cannot be counted in a lake, so samples are collected from pre-determined areas. In the case of Lake Metonga, plant samples were collected from plots laid out on a grid that covered the entire lake. Using the data collected from these plots, an estimate of occurrence of each plant species can be determined. In this section, relative frequency of occurrence is used to describe how often each species occurred relative to the other plants. These values are presented in percentages and if all of the values were added up, they would equal 100%. For example, if water lily had a relative frequency of 0.1 and that value was described as a percentage, it would mean that water lily made up 10% of the population.

In the end, this analysis indicates the species that dominate the plant community within the lake. Shifts in dominant plants over time may indicate disturbances in the ecosystem. For instance, low water levels over several years may increase the occurrence of emergent species while decreasing the occurrence of floating-leaf species. Introductions of invasive exotic species may result in major shifts as they crowd out native plants within the system.

Species Diversity

Species diversity is probably the most misused value in ecology because it is often confused with species richness. Species richness is simply the number of species found within a system or community. Although these values are related, they are far from the same because diversity also takes into account how evenly the species occur within the system. A lake with 25 species may not be more diverse than a lake with 10 if the first lake is highly dominated by one or two species and the second lake has a more even distribution.

A lake with high species diversity is much more stable than a lake with a low diversity. This is analogous to diverse financial portfolio in that a diverse lake plant community can withstand environmental fluctuations much like a diverse portfolio can handle economic fluctuations. For example, a lake with a diverse plant community is much better suited to compete against exotic infestation than a lake with a lower diversity.

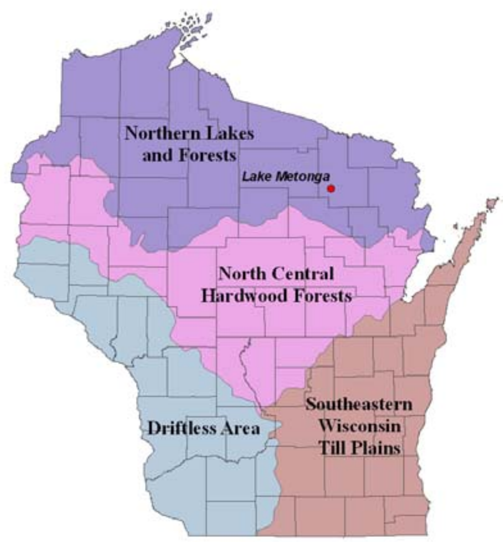

Figure 9. Location of Lake Metonga within the ecoregions of Wisconsin. After Nichols 1999.

Floristic Quality Assessment

Floristic Quality Assessment (FQA) is used to evaluate the closeness of a lake's aquatic plant community to that of an undisturbed, or pristine, lake. The higher the floristic quality, the closer a lake is to an undisturbed system. FQA is an excellent tool for comparing individual lakes and the same lake over time. In this section, the floristic quality of Lake Metonga is compared to lakes in the same ecoregion and in the state (Figure 9).

The floristic quality of a lake is calculated using its species richness and average species conservatism. As mentioned above, species richness is simply the number of species that occur in the lake, for this analysis, only native species are utilized. Average species conservatism utilizes the coefficient of conservatism values for each of those species in its calculation. A species coefficient of conservatism value indicates that species' likelihood of being found in an undisturbed (pristine) system. The values range from one to ten. Species that are normally found in disturbed systems have lower coefficients, while species frequently found in pristine systems have higher values. For example, cattail, an invasive native species, has a value of 1, while common hard and softstem bulrush have values of 5, and Oakes pondweed, a sensitive and rare species, has a value of 10. On their own, the species richness and average conservatism values for a lake are useful in assessing a lake's plant community; however, the best assessment of the lake's plant community health is determined when the two values are used to calculate the lake's floristic quality.

Community Mapping

A key component of the aquatic plant survey is the creation of an aquatic plant community map. The map represents a snapshot of the important plant communities in the lake as they existed during the survey and is valuable in the development of the management plan and in comparisons with surveys completed in the future. A mapped community can consist of submergent, floating-leaf, or emergent plants, or a combination of these life-forms. Examples of submergent plants include wild celery and pondweeds; while emergents include cattails, bulrushes, and arrowheads, and floating-leaf species include white and yellow pond lilies. Emergents and floating-leaf communities lend themselves well to mapping because there are distinct boundaries between communities. Submergent species are often mixed throughout large areas of the lake and are seldom completely visible from the surface; therefore, mapping of submergent communities is more difficult and often impossible.

2005 Comprehensive Survey Results

The aquatic plant surveys completed in 2005 located 34 aquatic plant species within Lake Metonga (Table 5) with the only non-native plant being Eurasian water milfoil.

Lake Metonga does not have any plants that completely dominate the system. Common waterweed and coontail (Figure 10) are the most abundant plants, but with the combination of high species richness and an even distribution of the species throughout the lake (relative frequency), the diversity is very high (Simpson's diversity = 0.93). Other common species that occur throughout much of the lake include wild celery and muskgrasses.

Overall, the FQA indicates that floristic quality of Lake Metonga (Figure 10) is excellent, especially when compared to median values for the state and ecoregion. As described above, floristic quality utilizes average conservatism value for all of the native species found in the lake and the total number of those species. Obviously, the high species richness of the lake is the major factor contributing to its excellent floristic quality as Lake Metonga's average conservatism value is slightly below the ecoregion median.

Median Value This is the value that roughly half of the data are smaller and half the data are larger. A median is used when a few data are so large or so small that they skew the average value to the point that it would not represent the population as a whole.

The Lake Metonga average conservatism values are only slightly higher than the state median and slightly less than the ecoregion median. This indicates that many of the species present in the lake are indicative of a somewhat disturbed system. This is not a surprise considering Lake Metonga has vast portions of developed shoreline and the lake experiences a great deal of recreational use. Still, the lake's plant community is outstanding as evidenced by the very high floristic quality and high index of diversity. The quality is also indicated by the high incidence of emergent plant communities that occur in many areas of the lake (Map 3). This is important, because these communities are often negatively affected by recreational use and shoreland development. Radomski and Goeman (2001) found a 66% reduction in vegetation coverage on developed shorelines when compared to undeveloped shorelines in Minnesota Lakes. Furthermore, they also found a significant reduction in abundance and size of northern pike (*Esox lucius*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*) associated with these developed shorelines. Many studies have documented the adverse affects of motorboat traffic on aquatic plants (e.g. Murphy and Eaton 1983, Vermaat and de Bruyne 1993, Mumma et al. 1996, Asplund and Cook 1997). In all of these studies, lower plant biomasses and/or declines and higher turbidity were associated with motorboat traffic.

Table 5. Aquatic plant species located in Lake Metonga during the 2005 surveys.

Life Form	Scientific Name	Common Name	Coefficient of Conservatism (c)
Emergent	*Carex comosa*	Bristly sedge	5
	Eleocharis palustris	Creeping spike-rush	6
	Equisetum fluviatile	Water horsetail	7
	Juncus pelocarpus	Brown-fruited rush	8
	Sagittaria latifolia	Common arrowhead	3
	Schoenoplectus acutus	Hardstem bulrush	5
	Schoenoplectus tabernaemontani	Softstem bulrush	4
	Typha latifolia	Broad-leaved cattail	1
	Zizania palustrus	Northern wild rice	8
FF	*Lemna minor*	Lesser duckweed	5
	Lemna trisulca	Forked duckweed	6
FL	*Nuphar variegata*	Spatterdock	6
	Nymphaea odorata	White water lily	6
FL/E	*Sparganium emersum*	Short-stemmed bur-reed	8
Submergent	*Ceratophyllum demersum*	Coontail	3
	Chara sp.	Muskgrasses	7
	Elodea canadensis	Common waterweed	3
	Heteranthera dubia	Water stargrass	6
	Isoetes lacustris	Lake quillwort	8
	Megalodonta beckii	Water marigold	8
	Myriophyllum sibiricum	Northern water milfoil	7
	Myriophyllum spicatum	Eurasian water milfoil	Exotic
	Najas flexilis	Slender naiad	6
	Nitella sp.	Stoneworts	7
	Potamogeton gramineus	Variable pondweed	7
	Potamogeton illinoensis	Illinois pondweed	6
	Potamogeton praelongus	White-stem pondweed	8
	Potamogeton pusillus	Small pondweed	7
	Potamogeton zosteriformis	Flat-stem pondweed	6
	Ranunculus flammula	Creeping spearwort	9
	Stuckenia pectinata	Sago pondweed	3
	Utricularia vulgaris	Common bladderwort	7
	Vallisneria americana	Wild celery	6
S/E	*Sagittaria graminea*	Grass-leaved arrowhead	9

FF = Free Floating
FL = Floating Leaf
FL/E = Floating Leaf and Emergent
S/E = Submergent and Emergent

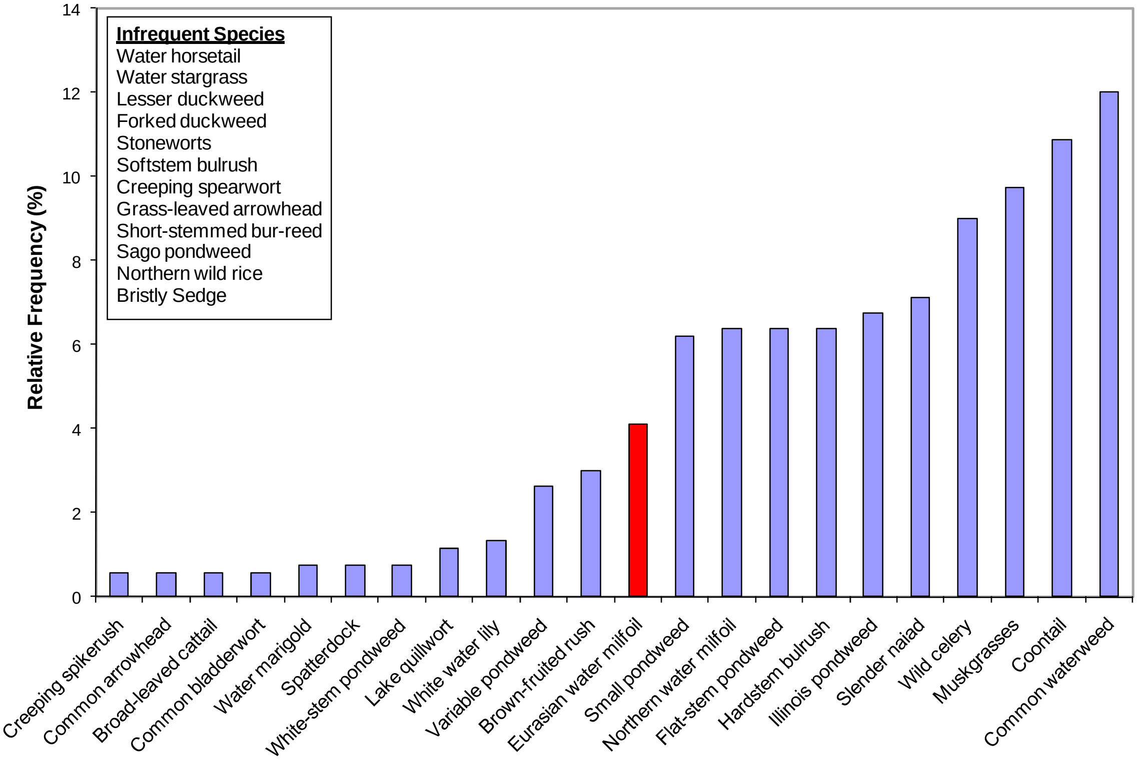

Figure 10. Lake Metonga aquatic plant occurrence analysis of 2005 survey data. Exotic species indicated with red.

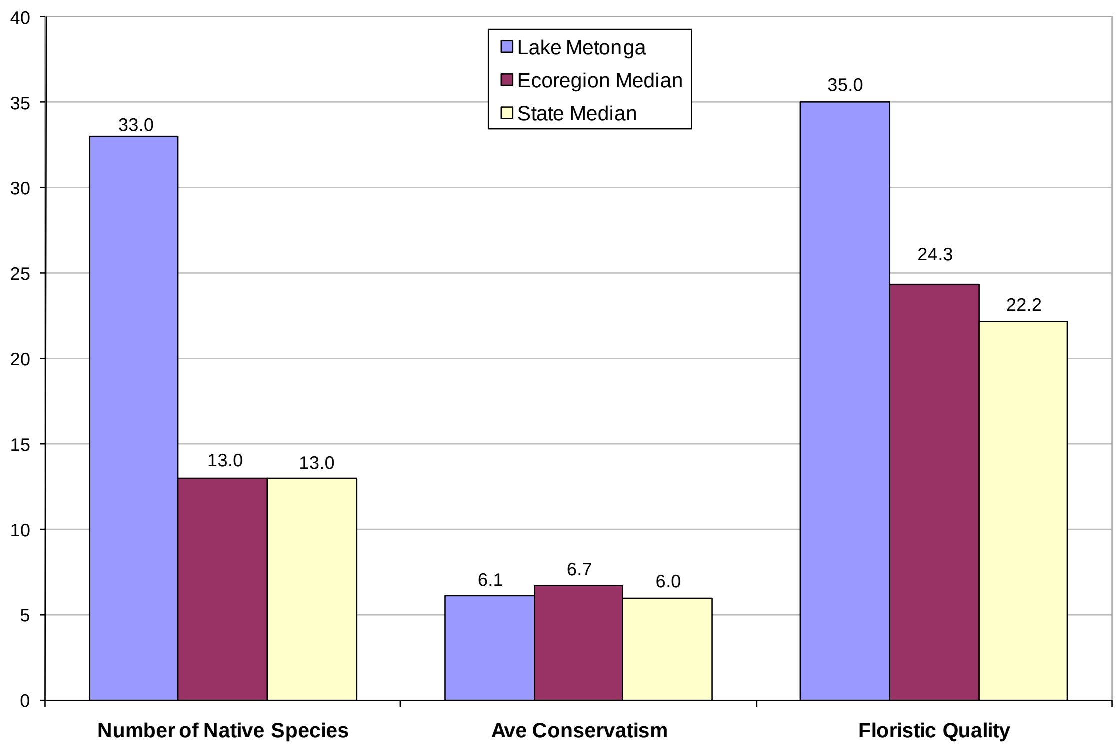

Figure 11. Lake Metonga Floristic Quality Assessment of 2005 survey data. Analysis following Nichols 1999.

Non-native Aquatic Plants

The LMA was primarily concerned with two plants, Eurasian water milfoil and curly-leaf pondweed. CLP was not known to exist in the lake, but Eurasian water milfoil was on the forefront of the association's concerns. Les Schramm provided Onterra with a sketched map depicting 6 Eurasian water milfoil colonies along with their respective estimated size which were thought to total 0.73 acres

Curly-leaf Pondweed

Curly-leaf pondweed is a European exotic first discovered in Wisconsin in the early 1900's that has an unconventional lifecycle giving it a competitive advantage over our native plants. Curly –leaf pondweed begins growing almost immediately after ice-out and by mid-June is at peak biomass. While it is growing, each plant produces many turions (asexual reproductive shoots) along its stem. By mid-July most of the plants have senesced, or died-back, leaving the turions in the sediment. The turions lie dormant until fall when they germinate to produce winter foliage, which thrives under the winter snow and ice. It remains in this state until spring foliage is produced almost immediately following ice-out, giving the plant a significant jump on native vegetation. Curly-leaf pondweed can become so abundant that it hampers recreational activities within the lake. Furthermore, its mid-summer die back can cause algal blooms spurred from the nutrients released during the plant's decomposition.

A meander survey was completed on June 23, 2005 in search of this invasive plant. No CLP was observed during this study and it was concluded that CLP was most likely not present in the lake and if it was present, it was at an undetectable level. In August 2006, there were reports of CLP being observed floating at one of the boat landings by Clean Boats Clean Waters inspectors, but its location in the lake has not been discovered.

Eurasian Water Milfoil

Eurasian water-milfoil is an invasive species, native to Europe, Asia and North Africa, that has spread to most Wisconsin counties (Figure 12). Eurasian water-milfoil is unique in that its primary mode of propagation is not by seed. It actually spreads mostly by shoot fragmentation, which has supported its transport between lakes via boats and other equipment. In addition to its propagation method, Eurasian water-milfoil has two other competitive advantages over native aquatic plants; 1) it starts growing very early in the spring when water temperatures are too cold for most native plants to grow, and 2) once its stems reach the water surface, it does not stop growing like most native plants, instead it continues to grow along the surface creating a canopy that blocks light from reaching native

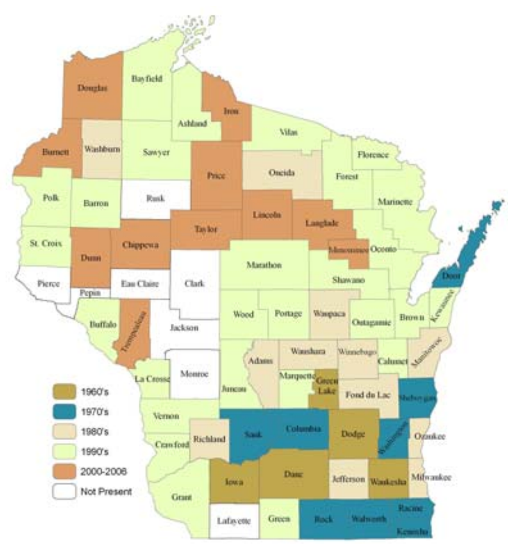

Figure 12. Spread of Eurasian water milfoil within WI counties. WDNR Data 2006 mapped by Onterra.

plants. Eurasian water-milfoil can create dense stands and dominate submergent communities, reducing important natural habitat for fish and other wildlife, and impeding recreational activities such as swimming, fishing, and boating.

2005-2007 Eurasian Water Milfoil Survey Results

2005 Treatment

Pretreatment Assessment (5/9/2005)

As stated earlier, a sketched map of 6 sites was provided by Mr. Les Schramm of the LMA. This map was digitized and given attributes using Geographic Information Systems (GIS) software. Placing a GPS waypoint in the center of each area, each location was navigated to. The purpose of the survey was to determine accurate extents of these focus areas for the LMA to determine chemical treatment options based on Onterra's recommendations. Resulting treatment sites were labeled and are shown on Map 4. The weather conditions at the time of the survey included light to moderate rain and a 10-15 mph wind from the west.

Site 1 According to notes made by Les, the area was presumed to be 120 by 60 feet (about 0.17 acres). Directly south of the public beach and boat launch area on the north side of the lake, Eurasian water milfoil was easily spotted in 7-10 feet of water with plants growing to about 6 feet from the substrate. Two large colonies (density of 90% aerial coverage) were mapped using polygons and several points were taken on smaller colonies or isolated clumps of plants. A treatment area of 4.2 acres was recommended.

Site 2 This area was presumed to be 130 by 40 feet (about 0.12 acres). This estimation was fairly accurate. The Eurasian water milfoil appeared to be most dense (80-90% aerial coverage) on the 8-9 foot contour and its extents were limited on two sides by depth. A treatment area of 0.1 acres was recommended.

Site 3 This area is directly lake ward from Strawberry Point, and estimated to be 80 by 30 feet (about 0.06 acres). In this area, Eurasian water milfoil grew to a depth of approximately 14 feet. The Eurasian water milfoil was about 7 feet tall and difficult to see from the surface without the aid of an Aqua Scope. Many GPS points were taken in an attempt to mark the extents of the colony. The density of this large colony was 50-100% aerial coverage and a two-part treatment area of a combined 8.0 acres was recommended.

Site 4 Les estimated this colony was 100 by 40 feet (0.09 acres). To allow Les to gain an understanding of the mapping process, he was asked to observe the process from our boat. Eurasian water milfoil densities were 80-100% aerial coverage in this colony and it was mapped using a polygon. The plants were easily observed from the surface in 8 feet of water. A 1.2 acre treatment area was recommended for the densest areas. Scattered plants were observed to the north and south of the recommended area but were not considered abundant enough to warrant a chemical treatment.

Site 5 The Eurasian water milfoil colony was originally thought to be 240 by 40 feet (about 0.22 acres). A very dense (100% aerial coverage) colony was mapped with a polygon. This colony appeared relatively isolated and growing in about 8 feet of water. The plants were highly visible from the surface, roughly 6 feet tall. A treatment area of 0.4 acres was recommended.

Site 6 The area directly north from the Forest County Memorial Park and south boat launch was thought to be 80 by 40 feet (about 0.07 acres). A dense area was observed in about 8-9 feet of water surrounded by a bit more scattering of plants. A 1.1 acre treatment area was recommended that included the entire colony, and the sparse occurrences due to the area being located in one of the highest traffic areas of the lake.

Post Treatment Assessment I (6/23/2005)

Previous to the visit, 14.9 acres of Eurasian water milfoil was chemically treated by Aquatic Biologists on May 24, 2005. The reason for the site visit was to perform the CLP survey, but since a crew was out on the lake, the six treatment areas were checked for Eurasian water milfoil. The weather conditions were favorable, 80ºF and mostly sunny. There was a southwest wind around 10 miles per hour that made observing submersed plants more difficult in some areas. The visits to the treatment areas lead to the concern that the Eurasian water milfoil treatment efforts were not effective. Laura Herman from the WDNR was contacted and it was agreed that she would meet with Les Schramm and Jim Goheen (Chemical applicator from Aquatic Biologists) at a later date. On June 27, 2006 these parties visited site 3, directly in front of Les's house, and it was concluded that the treatment was not successful and there was no clear reason. Also during the CLP survey, many new Eurasian water milfoil locations were marked to aid in the understanding of the infestation. Eurasian water milfoil was observed at this time to be reaching the surface and canopying to some degree. Many additional large colonies were also observed and mapped using a combination of polygons and point extents.

Post Treatment Assessment II (8/11/2005-8/12/2005)

This post treatment survey was conducted after the point-intercept plant study was completed. During that study, many additional Eurasian water milfoil locations were recorded on the lake including some large, dense colonies. The weather was warm and bright with the wind picking up in the afternoons. The results are presented in text below and summarized in Table 6.

Site 1 Plants were observed in this area very near the surface. One area appeared to have wilted plants, but the other areas yielded only healthy Eurasian water milfoil with some plants canopied. Overall the treatment did not look as if it adversely affected the plant. Many new plants were observed in the area including a very large colony directly to the east of Site 1. The area was considered of high concern and Tim Hoyman scuba dove the site on the last day to better determine the colony's extents. This new colony was isolated from Site 1 with only scattered plants in between.

Site 2 At this site, Eurasian water milfoil was observed and thought to look very similar to past visits. Much Eurasian water milfoil was observed to the north and south of the site along the 8 foot contour line. The treatment did not yield significant impacts in this site.

Site 3 This area was highly infested with Eurasian water milfoil. Plants were observed almost reaching the surface. The site was surveyed later in the day when the wind had calmed down and visibility was high. Upon finishing a detailed evaluation of the colony's boundaries and conditions, the area was designated to be dived the following day. Tim dove the area north to Site 2 and south to site 4. Treatment effects were not observed in this area.

Site 4 There was much Eurasian water milfoil around the site, but it the large colonies that made up the treatment site had Eurasian water milfoil that appeared limp and covered with filamentous algae. Much native milfoil was observed in the area.

Site 5 Similar to site 4, much Eurasian water milfoil was observed in the vicinity of the site, but the original colony appeared to have been affected. Plants observed in the treatment area were bent over and covered with filamentous algae.

Site 6 Plants were observed in this area about 1-2 feet from the surface in about 9.5 feet of water. It was unclear if the treatment had an effect in the area. Some plants appeared as if they may have been wilting while others appeared quite healthy.

2005 Conclusions

The WDNR, Aquatic Biologists Incorporated (ABI), LMA, and Onterra all concluded that the 2005 treatments were largely ineffective. Aquatic Biologists agreed to retreat the unsuccessfully treated areas (Site 1-6) at the same concentration at no cost to the LMA. However, no guarantees to the success of the repeat treatment were made due the company's assumption that the dose of the chemical may not have been high enough in this situation. Onterra, the WDNR, and the LMA agreed that the original concentration of 100 lbs per acre be used again on these sites. The decision was based on the fact that 100 pounds per acre seemed adequate during previous applications as well as on other lakes. Using the culmination of Eurasian water milfoil data from all previous studies, it was recommended that additional areas be treated on the lake. Using GIS software, 12 additional focus areas (12.9 acres) were created with the intent of refinement after the pretreatment assessment was completed. The LMA applied for chemical application permits for 2006 based on 27.8 acres (14.9 acres to be retreated and an additional 12.9 acres).

2006 Treatment

Pretreatment Assessment (5/10/2006)

18 sites, including the original 6, were surveyed to evaluate the Eurasian water milfoil and refine treatment options. All existing Eurasian water milfoil polygons and points were loaded into the GPS unit along with the treatment area polygons. This provided an accurate, real-time account of our location relative to treatment areas and past Eurasian water milfoil colonies while on the water. The conditions of the survey were mostly cloudy, cold, and a slight breeze. The water temperature was 50.2°F. Much Eurasian water milfoil was observed. New areas were noted as well as the expansion of existing colonies. Many areas that were previously too scattered to map using polygons were now easily mapped in that fashion.

After the survey was performed, Onterra recommended that only 13.36 acres of the original 14.9 be retreated this year because it appeared that there was an effect on the Eurasian water milfoil in two areas. The other 12 areas were refined from 12.9 acres to 13.1 acres. Some of the areas were expanded and others were reduced. Also, an additional 1.9 acres of recommended treatment area were added totaling 28.4 acres to be treated in May 2006.

Site 1 Both of the existing colonies located in this site were very dense (approaching 100% aerial coverage). The northwestern colony expanded much to the north and was mapped using a polygon. Plants were observed 2 feet from the surface in 8 feet of water. Since the treatment had no effect on the colony, it was recommended that the treatment be repeated and the northern expansion be treated as well.

Site 2 This colony's location was confirmed. Plants were observed very similar to past visits: low growing and along the 8 foot contour. Very dense and expansive colonies were mapped to the north and south. The original area was recommended to be retreated and additional treatment areas were added to the north and south.

Site 3 The northern part of this site had moderately dense Eurasian water milfoil (aerial coverage 60-75%) in most areas with a few areas being denser. The plants were growing out to

14 feet of water and were only visible from the surface using an Aqua Scope or submersed video. The lower part of the site was considerably more dense including one area that was arguably the most dense colony in the lake. This area was recommended to be retreated.

Site 4 This area had very sparse Eurasian water milfoil plants. There were considerably more plants located on the eastern edge in an area just outside of the treatment area. It was recommended that this site not be retreated since the original treatment appeared to successfully impact the colony including the current year's plant growth. However, additional treatment areas around the site were recommended.

Site 5 There were very few plants observed in this site. Also, very few plants were observed in the vicinity of the site. It was concluded that the treatment also had a positive effect and a repeat treatment was not justified. Adjacent colonies were recommended for treatment.

Site 6 The Eurasian water milfoil colony appeared healthy in this area and many scattered plants were observed surrounding the treatment area. Areas that were previously observed to be moderately dense were now indistinguishable from the more dense portions of the area. This site was recommended for repeat treatment. A large colony of Eurasian water milfoil was located to the east of this area just outside the campground's swimming area. The densest portion of this colony was recommended for treatment and future monitoring will be needed.

Site 7 A half-acre square treatment area was originally devised for this site. Based upon the 2005 surveys, Eurasian water milfoil was most dense (aerial coverage of 90-100%) in this area but was found to extend to the east (aerial coverage of 50-75%). The square treatment area was refined into a rectangle of about 1.2 acres. There were scattered plants extending northeast along this contour band and is recommended for future monitoring.

Site 8 Located directly west of the boat landing on the east side of the lake, a heavy colony of Eurasian water milfoil (approaching aerial coverage of 100% and canopying) was mapped during the comprehensive survey. During the current study, the colony was re-mapped. The polygons from the two surveys were almost identical showing little change in colony size. An area of 0.8 acres was recommended for treatment.

Site 9 This area of infestation occurs between the 7 and 13 foot contour. The colony extents were verified. The treatment area was originally given a 0.7-acre rectangle and was revised to a slightly different shape of roughly the same acreage.

Site 10 Eurasian water milfoil was moderately dense in this area (50-75% aerial coverage) with scattered plants observed outside of the initial treatment area. The area was revised from about a half an acre to 1 acre to include the scattered plants located outside the main colony.

Site 11 The extents of this area were almost entirely accurate. Eurasian water milfoil in this area is most dense (80-90% aerial coverage) in the western portion of the treatment area. 1.8 acres of chemical treatment was recommended for this site.

Site 12 Partially located in the swimming area of the Crandon Municipal beach and boat landing, this Eurasian water milfoil colony is very dense (90-100%). This area is of concern because its proximity to the boat landing and its encroachment on a recreational area. The area was only partially mapped during the comprehensive plant survey because the beach area was in use. The colony was remapped and appeared that it expanded quite a bit from the previous year. This treatment area was expanded from 0.8 acres to 1.7 acres. Additional plants were observed to the east and will need future monitoring.

Site 13 This Eurasian water milfoil colony is growing on a steep ridge in approximately 7-10 feet of water. Plants were observed in this area, but since this colony is so limited by depth, it was recommended to give priority to other colonies and not treat the site at this time.

Site 14 There is one large Eurasian water milfoil colony (80-90% aerial coverage) that is contained within this treatment area. Scattered Eurasian water milfoil is located throughout the site and the initial 2.01 acre treatment area was recommended.

Site 15 The site appeared similar to past surveys and the 1.63 acre treatment recommendation was accurate. This site contained one dense colony (90% aerial coverage) and many other scattered plants.

Site 16 This site is located in Strawberry Bay to the south of Site 3. The Eurasian water milfoil was scattered with larger clumps of roughly 10 ft in diameter. Although this area is not as dense as some, the 1.11 acres are recommended for treatment to keep the area around Site 3 under control.

Site 17 As noted earlier, much Eurasian water milfoil was observed surrounding Site 5. A few 40 foot diameter colonies of Eurasian water milfoil were observed almost reaching the surface. It was recommended that all 1.24 acres of the focus area be treated.

Site 18 This colony was located in the deepest water of any known colony on the lake and was not visible from the surface. A combination of submersed video and buoy placement was used in an attempted to delineate the extents of the colony. This method did not sufficiently work in this situation and it was determined that future studies and alternative methods (scuba) will be needed to understand this colony's extents. Priority was given to other Eurasian water milfoil colonies and this site was not treated.

Sites 19-23 These sites were all added after the pretreatment survey and totaled 1.93 acres. These areas were selected for treatment because they had dense (75-80% aerial coverage) colonies of Eurasian water milfoil with distinct boundaries. Site 19 is located directly lake ward from a large resort area. High boat traffic in this area could increase fragmentation of Eurasian water milfoil and increase its ability to spread.

Post Treatment Assessment I (6/30/2006)

The survey was to qualitatively evaluate the Eurasian water milfoil treatments that were completed by Schmidt's Aquatic Plant Control and Aquatic Biologists, Inc. on May 15-18, 2006. All treatment sites were visited during the 8-hour survey. Submerged video was shot using scuba at sites 1, 3, and 12. These sites were also videoed before the treatments occurred in mid May 2006. The video will be made available when time permits. Conditions during the site visit were nearly perfect with partly cloudy skies and little wind. The results of the treatments were largely inconclusive at the time of the survey and a second post treatment survey was deemed necessary.

Sites 2, 3, 6, 7, 14, 15, 16, 17, and 19 These sites all showed very good results because little or no Eurasian water milfoil was found. The Eurasian water milfoil that was seen was very limp and collapsed. Most of these sites also had good occurrence of native plants. Some sites, such as 2 and 15, had a great deal of native milfoils, indicating that the timing of the treatment was good and minimized the impact on these important plants.

Site 11 Overall this site appeared that the chemical treatments were affective, but some standing, limp Eurasian water milfoil was located. It was presumed that these plants would show more affects later in the summer.

Sites 1, 8, 9, 10, 12, 20, 21, 22, and 23 These sites showed mixed results. In all of these sites, a great deal of Eurasian water milfoil was found, but rake tows indicated much leaf-burn, some adventitious root development, and the plants were very limp. It was obvious that the treatment had an impact and likely slowed or stopped the growth of the Eurasian water milfoil; however, is not known why these plants hadn't fallen over and it is hoped that they would later in the season.

Post Treatment Assessment II (8/15/2006)

During this survey, all 19 treatment sites were visited along with the 4 sites that were not treated. From our experience on many other lakes during 2006, Eurasian water milfoil growth was quite high and Lake Metonga was no exception. Much Eurasian water milfoil was observed on the lake and many new colonies were mapped. During the survey, the conditions were 70˚F, sunny and a light breeze. The results are presented in text below and in Table 6.

In the interest of clarity, the following qualitative terms are used in describing the treatment results on a site-by-site basis:

> *Good* This term is used on sites that an obvious decrease in Eurasian water milfoil density was observed following the treatment. For example, areas containing a dense colony that were found to have only a few scattered plants or only a few clumps of Eurasian water milfoil were considered to have good results.
>
> *Moderate* Sites with this determination showed treatment results in one of two ways. Some sites were found to have a decrease in Eurasian water milfoil density, but healthy plants remained to some extent. At some sites, there was not a clear decrease in density, however, the plants that remained were obviously impacted because they were found to be limp and have an unhealthy appearance.
>
> *Poor* This term is used for sites that had very little, if any, apparent treatment results. In these sites, there was not a decrease in apparent Eurasian water milfoil density and the majority of the plants appeared to be thriving.
>
> *Mixed* Sites with this determination were found to show a combination of the above terms. For instance, a large site may have a portion showing good results because very little Eurasian water milfoil was found in it; however, in a different portion standing plants were found that may have had a healthy (poor result) or unhealthy (moderate result) appearance.

Site 1 *Site-wide Effect: Moderate.* Although some areas had a successful reduction in Eurasian water milfoil density, others areas within the site had Eurasian water milfoil that appeared healthy. This rectangular treatment site could be refined to a slightly different shape to make future treatments more efficient.

Site 2 *Site-wide Effect: Good.* Much northern water milfoil was observed in this area with only 1 small clump of Eurasian water milfoil.

Site 3 *Site-wide Effect: Good.* This large, 2-part treatment area showed good results. The northern portion of the treatment area was virtually free from Eurasian water milfoil. The southern portion had scattered Eurasian water milfoil but no distinct colonies including the dense colony mapped in August 2005. The density of the Eurasian water milfoil in this area was greatly reduced.

Site 4 This site was not treated in 2006. Almost no Eurasian water milfoil was observed in or around this site.

Site 5 This site was not treated in 2006. No Eurasian water milfoil was observed in this site.

Site 6 *Site-wide Effect: Good.* This colony appeared much reduced from past surveys. One heavy (aerial coverage 80 %) Eurasian water milfoil colony still exists but the rest of the treatment area was virtually free from Eurasian water milfoil.

Site 7 *Site-wide Effect: Good.* The Eurasian water milfoil colony in the treatment area was greatly reduced in size and density. The Eurasian water milfoil that was observed was low-growing. Many native plants were observed in this treatment area.

Site 8 *Site-wide Effect: Good.* Although the entire area was scattered with Eurasian water milfoil, this is a distinct reduction from the previous year. Many natives were also observed in this area.

Site 9 *Site-wide Effect: Poor*. Some areas of this site had limp Eurasian water milfoil but most of the Eurasian water milfoil appeared healthy. The Eurasian water milfoil was growing in 7-9 feet of water and was roughly 3 feet from the surface.

Site 10 *Site-wide Effect: Mixed.* Many scattered plants were observed growing low and bent over, but a 40 foot diameter dense colony (aerial coverage 90%) was observed in the western part of the treatment area. These plants appear healthy and approaching the surface.

Site 11 *Site-wide Effect: Good.* There was very little Eurasian water milfoil observed in this site and the plants that were observed appeared to be impacted by the treatment.

Site 12 *Site-wide Effect: Moderate.* This site had much Eurasian water milfoil and it was unclear how much of it was adversely affected by the treatment. Eurasian water milfoil appeared to be less dense and did not reach as close to the surface. However, it appeared that this colony grew substantially to the east along the 7-9 foot contour and is an area that will need future monitoring.

Site 13 This site was not treated in 2006 and the colony appeared similar to past surveys. Plants were located and tightly hugged the 7-10 foot contour which is very steep and narrow.

Site 14 *Site-wide Effect: Good.* Much of this area was clear of Eurasian water milfoil. One 10 foot diameter clump was observed in the center of the treatment area and had standing plants.

Site 15 *Site-wide Effect: Good.* There was almost no Eurasian water milfoil observed in or around this site.

Site 16 *Site-wide Effect: Good.* Almost no Eurasian water milfoil was observed in the site.

Site 17 *Site-wide Effect: Good.* Very few plants were observed in this site.

Site 18 Site 18 was not treated in 2006 and this site was not evaluated during this site visit.

Site 19 *Site-wide Effect: Good.* This site was added after the spring pretreatment survey and had a large, dense colony. This visit yielded almost no Eurasian water milfoil and it appears that the treatment was quite effective.

Site 20 *Site-wide Effect: Good.* The Eurasian water milfoil was very scattered in this site. Some areas had no Eurasian water milfoil and the areas that Eurasian water milfoil was present appeared limp and bent over.

Site 21 *Site-wide Effect: Good.* The Eurasian water milfoil was almost entirely gone in this site. Only a thin band of low-growing Eurasian water milfoil existed in 7 feet of water.

Site 22 *Site-wide Effect: Moderate.* There was some Eurasian water milfoil standing in this site but it was completely covered with filamentous algae.

Site 23 *Site-wide Effect: Moderate.* Eurasian water milfoil was not observed in some parts of the treatment site but in others it appeared quite healthy aside from being covered with filamentous algae.

Table 6. Eurasian water milfoil treatment summary.

Site	First Mapped	2005 Treatment Acreage (May 24, 2005)	2005 Treatment Results	2006 Treatment Acreage (May 15, 2006)	2006 Treatment Results	Notes
1	May 2005	4.15	Ineffective	4.15	Moderate*	*Some reduction in density but healthy Eurasian water milfoil observed
2	May 2005	0.11	Ineffective	0.11	Good	
3	May 2005	3.98	Ineffective	7.98	Good*	*Northern portion relatively free of Eurasian water milfoil, southern portion has density much reduced but scattered plants
4	May 2005	4.00	Ineffective*	Not Treated		*Treatment later shown to have an effect
5	May 2005	1.20	Ineffective*	Not Treated		*Treatment later shown to have an effect
6	May 2005	0.36	Ineffective	1.11	Good	
7	August 2005			1.23	Good	
8	August 2005			0.78	Good	
9	August 2005			0.67	Poor*	*Only limited treatment effects observed
10	August 2005			1.00	Mixed*	*Eastern part effective, Eurasian water milfoil in western part appeared healthy
11	August 2005			1.78	Good	
12	August 2005			1.65	Moderate*	*Density reduced in much of area but some healthy plants
13	June 2005			Not Treated*		*Priority given to other areas
14	June 2005			2.01	Good*	*Only 1 small colony observed
15	May 2005			1.63	Good	
16	May 2005			1.11	Good	
17	August 2005			1.24	Good	
18	May 2005			Not Treated*		*Colony in deep water and priority given to other colonies
19	May 2006			0.48	Good	
20	May 2006			0.30	Good*	*Highly scattered Eurasian water milfoil observed but limp and bent over
21	May 2006			0.60	Good	
22	May 2006			0.30	Moderate*	*Some Eurasian water milfoil observed covered with filamentous algae
23	May 2006			0.25	Moderate*	*Some Eurasian water milfoil observed covered with filamentous algae

2006 Conclusions

In May 2006, just over 28 acres of Eurasian water milfoil was treated. Post treatment qualitative results based on a site-by-site basis conclude that 72% of the acreage was found to have good results, while 22% was considered to have moderate results and 4% showed mixed results. The remaining acreage (2%) was found to have poor results. Although the majority of the sites showed a good treatment result, most could be considered dense enough to warrant chemical treatment in 2007. The preliminary treatment plan for 2007 was to consider all past treatment areas as *focus areas* (Map 5) as well as newly mapped areas. Therefore, a total 44.0 acres was used to create the conditional permit. It was presumed that the best time to determine if a particular site needed treatment would be in May of 2007. It was hypothesized that some of these focus areas would have responded to the chemical treatments, similar to the delayed responses after the 2005 treatment, and therefore would not need treatment.

2007 Treatment

During the surveys of 2007, two different methods of evaluation were used to understand the level of control that was achieved by the chemical treatment. A qualitative assessment was determined for each treatment site by comparing detailed notes of pre- and post treatment observations and spatial data collected with a sub-meter GPS datacollector. A quantitative assessment of the treatment was also made by collecting data at 93 point-intercept sample locations before and after the treatment (Appendix ?). At these locations, Eurasian water milfoil presence and rake fullness was documented as well as water depth and substrate type. Native plant abundances were also determined at each plot during the pre- and post treatment surveys; however, these data are only lightly discussed here because comparisons between early spring samples and summer samples are not valid due to the lifecycles of these species.

Pretreatment Assessment (5/03/2007 & 5/15/2007)

The purpose of this survey was to visit the 44.0 acres of potential Eurasian water milfoil treatment areas used in the conditional permit to more accurately and effectively coordinate the control method. The first visit to Lake Metonga on May 3 was full sun and water clarity was high. Notes were made on each potential treatment area and some extents were refined based on the observations. It was concluded that there were almost no noticeable ‘delayed responses’ and all areas had enough Eurasian water milfoil in them to warrant a treatment. On the lake, it was decided that up until that point, the treatments truly had not provided the level of success needed to yield lake-wide control of Eurasian water milfoil on Lake Metonga and that a new strategy needed to be adopted. A subset of the treatment areas were visited and refined to serve as experimental treatment sites at an increased dose of 150 lbs/acre. After conversations with the LMA and the WDNR, this approach was agreed upon and on May 15, 2007, Onterra made another site visit to perform the point-intercept sub sampling that would serve as the quantitative assessment.

Please note that treatment site names from 2005 & 2006 (Maps 4, 5) do not correspond with the site names from 2007 (Map 6). 2007 treatment site names are alphabetical as opposed to the past numeric labels.

Site A Located just lake ward from the Crandon Municipal Public Beach and Boat Landing, this very dense Eurasian water milfoil colony had expanded since the 2006 treatment (Map 6, Site

12). Of the 21 point-intercept locations sampled, 76.2% contained Eurasian water milfoil (Figure 13).

Site B Comprised of past treatment sites 1 and 23, this location has been treated since 2005. 54% of the 24 point-intercept locations sampled contained Eurasian water milfoil (Figure 13).

Site C This location was treated in 2006 (Map 5, Site 21) with moderate results. This site was smaller and deeper than the other 2007 treatment sites and could provide insight for future management decisions. No sub-sampling occurred in this site.

Site D Extending north from site 8 and engulfing site 20, this large treatment site contained the most and densest Eurasian water milfoil of the other areas. Twenty-one of the 24 point-intercept locations contained Eurasian water milfoil (87.5%).

Sites E & F Comprised of past treatment sites 7 and 6 (respectively), these sites straddle the public beach at Veteran's Memorial Park, a county operated campgrounds. No sub-sampling occurred at this site.

Site G Once the northern portion of site 3 and locally known as 'off strawberry point' this treatment area has been treated annually since 2005. Of the 24 point-intercept locations sampled, 58.3% contained Eurasian water milfoil (Figure 13).

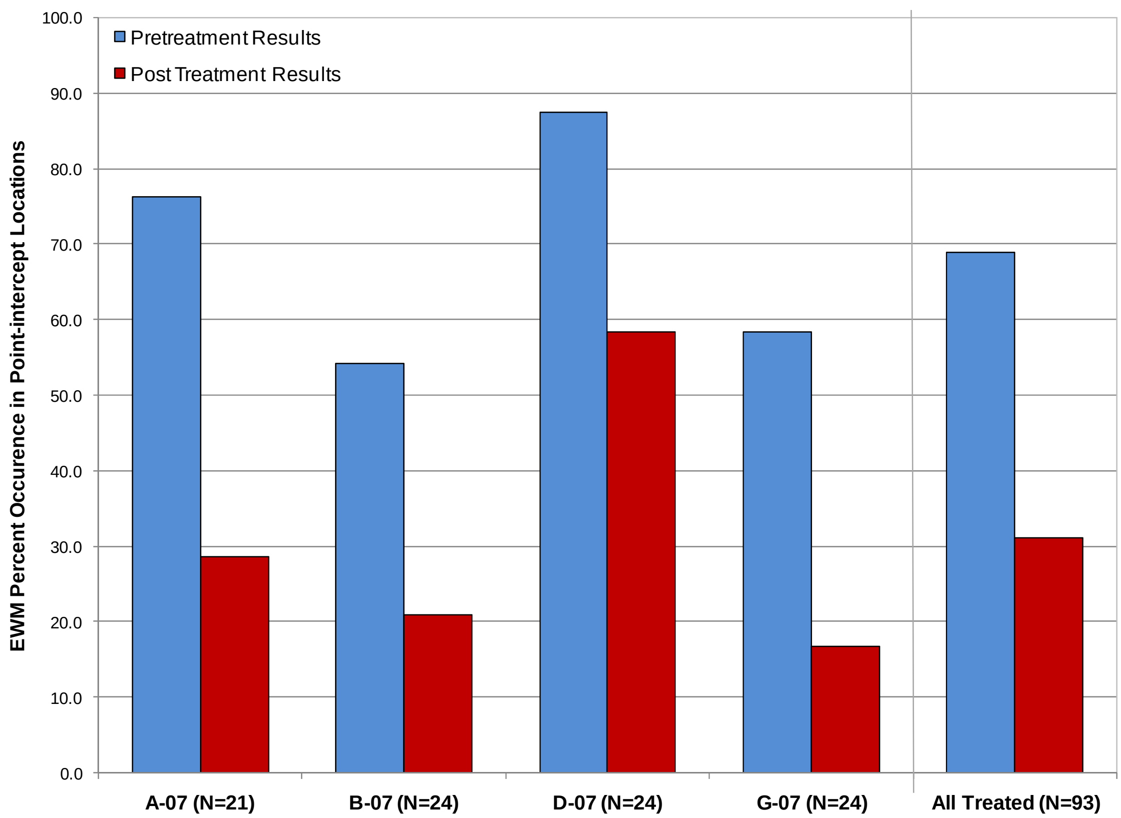

Figure 13. Eurasian water milfoil percent occurrence in treatment monitoring point-intercept locations from 2007.

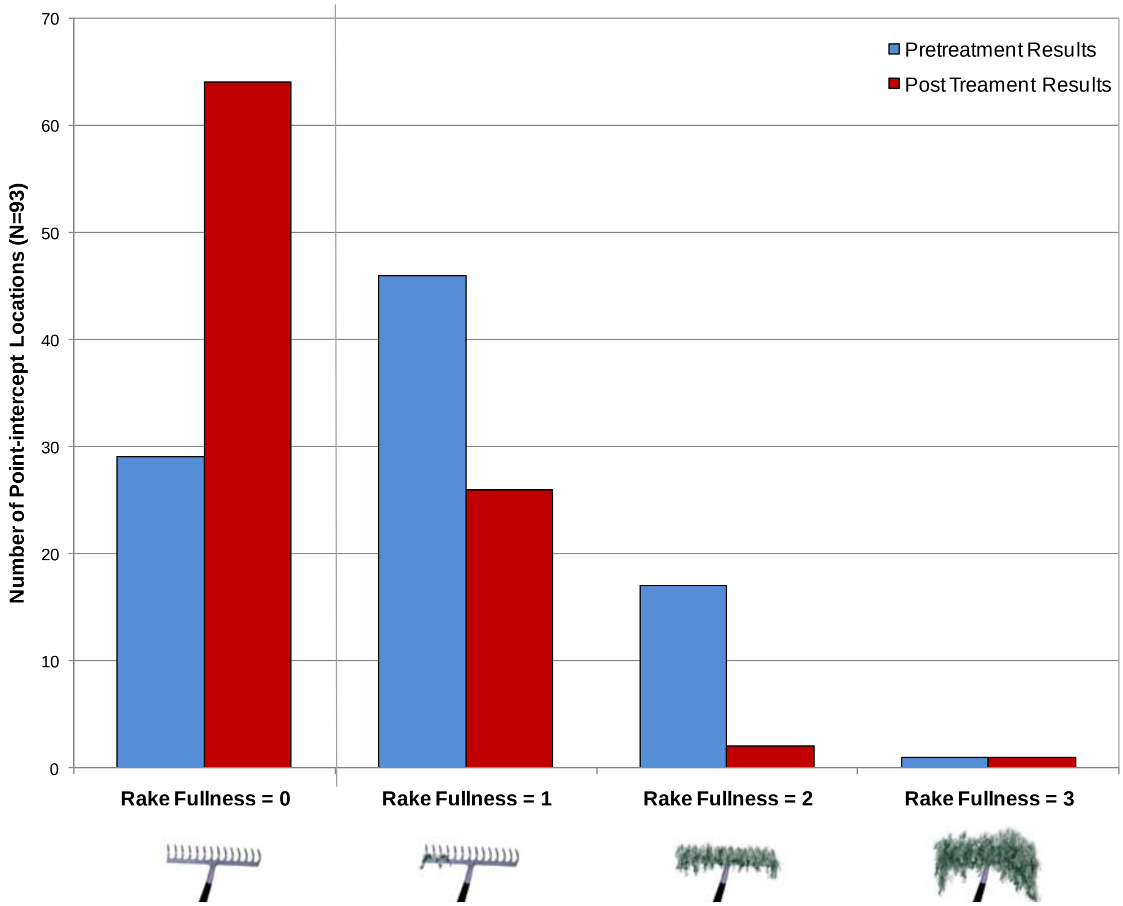

Figure 14. Eurasian water milfoil rake fullness distribution in treatment monitoring point-intercept locations.

Post Treatment Assessment (8/03/2007)

During this survey, all treatment areas were visited to determine the efficacy of the chemical application. All point-intercept sample locations were re-visited and data were collected in the same manner as during the pretreatment survey. Water clarity was good and plants could be observed growing in 14 feet of water. The littoral zone of the lake was searched and Eurasian water milfoil was mapped for future management activities (Map 7).

Site A Almost no Eurasian water milfoil was located in this site after treatment. Native plants, especially water celery were observed. A scuba review of the area confirmed the change in Eurasian water milfoil density. Only 28.6% of the 21 point-intercept sample locations contained Eurasian water milfoil.

Site B Eurasian water milfoil was reduced by size and density in this location, but was still observed. The remaining Eurasian water milfoil was mostly contained in a single colony that was delineated for future management. After treatment, 20.8% of the 24 sample locations contained Eurasian water milfoil.

Site C The treatment had profound effects on this site. Eurasian water milfoil was not observed in this site and many natives including Illinois pondweed were observed growing at the surface.

Site D The treatment was the least effective in this location. Eurasian water milfoil quantity and density appeared similar to before the treatment with more Eurasian water milfoil being observed to the north of the treatment site. The results of the sub-sampling showed that there was a reduction in Eurasian water milfoil occurrence. 58.3% of the 24 sample points contained Eurasian water milfoil after the treatment compared to 87.5% that contained Eurasian water milfoil before the treatment.

Sites E & F A high amount of treatment effectiveness was observed in these locations with only small amounts of Eurasian water milfoil being present. Northern water milfoil was observed growing in most of the treatment area, almost forming a carpet of native milfoil.

Site G Aside from a small colony in the northwest corner, this treatment site showed great results. Only 16.7% of the 24 point-intercept locations contained Eurasian water milfoil after the treatment.

2007 Conclusions and Recommendations

Before the treatment, 69% of the point-intercept locations contained Eurasian water milfoil and approximately 31% contained Eurasian water milfoil after the treatment (Figure 13). A rake fullness rating of 1-3 was used to determine abundance of the Eurasian water milfoil at each location. Figure 14 displays the number of point-intercept locations exhibiting each of the rake fullness ratings.

Because of the lifecycle of native plants, they should be at very low biomass (or not even started growing yet) during the spring survey. However, it is important to understand the effects of the dicot-specific herbicide on some of the broad-leafed natives. Table 7 shows that coontail and northern water milfoil were not adversely affected by the treatment. Common waterweed, a monocot, increased its occurrence from 20.4% to 22.6%.

Table 7. Percent occurrence of select native plants from the 2007 treatment monitoring point-intercept survey.

	% Occurrence	
Species	**Pretreatment Results**	**Post Treatment Results**
Coontail	24.7	25.8
Northern water milfoil	10.75	8.6
Stoneworts (macro-algae)	1.1	2.2

It is perceived that the level of control achieved from the 2007 chemical treatments conducted on Lake Metonga was high, especially in areas that were treated in previous years. Because the 2007 chemical treatments were largely experimental, not all areas that needed treatment were treated. Map 7 shows the locations of Eurasian water milfoil from the peak biomass survey completed on August 2 and 3, 2007. Small amounts of Eurasian water milfoil were observed in other areas of the lake, but this map only focuses on the denser colonies of Eurasian water milfoil. A conditional permit for chemical application on Lake Metonga will include the 41.9 acres of treatment areas found on Map 7 and the pretreatment survey may result in a reduction of the total acreage due to the condition of the Eurasian water milfoil just prior to treatment. Combining the limited success in previous years when treatment dosages were 100 lbs/acre with the successes observed in 2007 when treatment dosages were 150 lbs/acre, future treatments should take into considerations physical parameters that affect herbicide concentration within the water column. With the support of the WDNR, the next Environmental Protection Agency (EPA) approved label for Navigate® will list concentrations by volume as opposed to the current listing by surface area. Because of the great water depths that Eurasian water milfoil grows in Lake Metonga and the density of the target Eurasian water milfoil colonies, treatments in 2008 should continue at 150 lbs/acre. An exception is site K (Map 7) where plant densities are relatively high, water depths exceed 13 feet, and the fact that this location has never been treated where it is presumed that a higher herbicide dose (200 lbs/acre) will be needed to result in a successful treatment.

SUMMARY AND CONCLUSIONS

The studies and surveys completed as a part of the management planning project have shed light on many aspects of the Lake Metonga ecosystem. This information is essential in the development of a realistic and implementable management plan for the lake. The majority of the information related within this document was collected during the completion of two projects; the first an Aquatic Invasive Species Project (ACEI-001-05), and the second, this Lake Management Planning Project (LPL-1178-07). A side benefit of completing this project is the condensing of the data, results, and conclusions of these two projects.

Data primarily collected by volunteers from the LMA and analyzed as a part of this project, indicates that the water quality of Lake Metonga is very good. This is evident as total phosphorus, chlorophyll-*a*, and Secchi disk clarities that are consistently better than average values found in Wisconsin lakes and the lakes in Lake Metonga's region. The fact that there is so much reliable historic data available lends to the validity of these conclusions and is directly attributable to the incredible efforts of the LMA and the support provided to them by the WDNR. Continued collection of water quality data is still appropriate as it will build the dataset and make future long-trend analysis more reliable.

The only aspect of the water quality data that is lacking is the availability of phosphorus concentrations from the lake's hypolimnion during summer stratification, which prevented the modeling of potential internal nutrient loads. Although internal loading may not be a significant source of phosphorus in the lake's nutrient budget at this time, it would be good to document its potential now for use in comparisons in the future.

The overriding factor in Lake Metonga's water quality is the lake's watershed. This small watershed, combined with the lake's immense volume leads to the low phosphorus concentrations that keep algae production low and clarity values high. The only significant unknown is the impact of the urbanized area of the watershed (City of Crandon). Closer examination of the runoff entering the lake that originates in the city would lead to a better understanding of the area's contribution to the lake's nutrient budget and may also lead to simple actions that may reduce the lake's total nutrient (and sediment) load significantly.

As discussed in the Aquatic Plant section, the native plant community of Lake Metonga is highly diverse and of high quality. It has many stands of lush emergent and floating-leaf vegetation that provide valuable fish and wildlife habitat and are aesthetically pleasing. Unfortunately, this outstanding plant community is threatened by the growth and expansion of Eurasian water milfoil.

Studies conducted since 2005 have documented that Eurasian water milfoil is spreading to new areas in the lake and in those areas, has the ability to form dense stands leading to monoculture stands. Early attempts to control the plants through biological and chemical techniques proved to be unsuccessful on a lake wide basis. Fortunately, the chemical treatments completed in 2007, using a dosage of 150 lbs/acre provided excellent control within all of the treatment areas, except one (Site D). This site was the only area not treated previously, which may have been a contributing factor leading to the less than acceptable control. As described in the 2007 treatment conclusions, these results may indicate that an increased dosage over 150 lbs/acre may be required to achieve acceptable control in the first year when new areas of dense stands in deep water are treated.

Finally, a statement must be made regarding the perceptions that the Lake Metonga stakeholders have about their fine resource. Because of the large return rate of the surveys (60%) (Appendix B), the stakeholder survey for Lake Metonga can be used as a powerful tool to understand the perceptions of the lake's stakeholders. One positive observation of the survey is stakeholders ranked 3 passive recreational activities as their most enjoyable on Lake Metonga (Appendix B, Question 7). Swimming, as an enjoyable activity, most likely was ranked highly because of the stakeholder's perceptions of Lake Metonga having good water quality. Almost 92% of respondents thought that the water quality on Lake Metonga was fair or excellent (Appendix B, Question 11) and it is a safe assumption that better water quality equates to better swimming conditions.

However, with almost half the respondents believing the water quality has degraded since they obtained their property, perhaps the role aquatic invasive species are having on the lake is becoming evident in the minds of stakeholders (Appendix B, Question12). Actually, 99% of the respondents are aware of aquatic invasive species in Lake Metonga (Appendix B, Question 14) and 85% listed aquatic invasive species as one of their top 3 concerns regarding Lake Metonga (Question 15). It is not surprising that almost 98% of the same respondents believe aquatic invasive species are having a moderate or great negative impact on Lake Metonga (Appendix B, Question 16). Perhaps it is because stakeholders are aware of aquatic invasive species and the threat they pose that almost 75% are either moderately or highly supportive of the responsible use of herbicide control measures on Lake Metonga (Appendix B, Question 19).

It is noted that 15% of respondents were not in favor of herbicide use; however, to date there have not been any documented opposition to the treatments. Each year, a public notice is included in the Forest County Republican, the local newspaper. Consistent with NR 107, a public information meeting would be scheduled if more than 5 individuals (or entities) requested such in writing

A number of survey respondents also commented about low water levels in Lake Metonga and their thoughts that increasing the height of their low-level water control structure (dam) would raise the water levels. This thought process assumes that there is enough water entering the lake to raise the water levels. The concrete dam located on the south end of the lake was rebuilt in 1969 and was fixed at a level (weir of 99.42) that could artificially increase the lake's water level up to four feet (LMA 2002a). However, it is not necessarily true that if the dam height was raised, the water level of the lake would also rise proportionately. Lake Metonga is a headwater drainage lake that receives the majority of its water from the aquifer (groundwater supply). Drainage lakes are highly influenced by reductions in annual precipitation and the low water levels observed on Lake Metonga are largely a product of the low precipitation levels observed in the region over the past few years. Therefore, raising the dam height would not necessary raise lake levels if the ground water flow to the lake is not sufficient.

Appendix B provides all the results of the stakeholder survey as well as comments that were made by respondents.

IMPLEMENTATION PLAN

The intent of this project was to complete a *comprehensive* management plan for Lake Metonga. As described in the sections above, a great deal of analysis was completed involving many aspects of the Lake Metonga ecosystem. The conclusions drawn from those analyses and backed with information provided by the Planning Committee has lead to the decision that this management plan must prioritize the control of Eurasian water milfoil in Lake Metonga. This decision is also substantiated with the results of the stakeholder survey as 85% of survey respondents ranked AIS as either their first, second, or third greatest concerns regarding Lake Metonga (Appendix B, Q15) and 65% believe AIS are having a great negative impact on the lake (Appendix B, Q16). Naturally, because the term "AIS" is used, we cannot assume that all of these respondents are thinking purely about Eurasian water milfoil as they answer these questions. However, based upon the overwhelming belief that aquatic plant control is needed on Lake Metonga (Appendix B, Q18), we can attribute much of their concern over AIS to Eurasian water milfoil.

The Implementation Plan presented below has two management goals. The first and most comprehensive is the goal of controlling Eurasian water milfoil, reducing its spread, and preventing further infestations of the exotic. Regarding the latter portion of the goal, the prevention of further infestations is not only aimed at preventing additional infestation into Lake Metonga, but also at preventing Lake Metonga from acting as a source of AIS for other waterbodies. Meeting this management goal will be facilitated through five management actions aimed at controlling existing infestations within the lake through integrated techniques, the monitoring of the native and non-native plants within the treatment areas and on a whole-lake basis, and the minimization of further infestations as discussed above.

The second management goal is create an updated management plan for Lake Metonga, starting in 2011. Once an established Eurasian water milfoil control and prevention program is in place on Lake Metonga, attention will need to be granted to other components of the lake's management, specifically water quality, nutrient management, shoreland restoration, and native aquatic plants.

Management Goal 1: Control Eurasian Water Milfoil, Reduce its Spread, and Prevent Other Infestations

Management Action: Enhance Clean Boats Clean Waters watercraft inspections to include all Lake Metonga Public Boat Landings.

Timeframe: Start 2008 or 2009

Facilitator: Planning Committee

Description: Currently a partnership between the Mole Lake Chippewa Community and the City of Crandon supports a Clean Boats/Clean Waters (CBCW) program at the City of Crandon Municipal boat landing (Appendix A: LMA Spring Newsletter). At this landing, two employed youths assist and educate boaters on AIS. When they are not attending to boaters, the enclosed trailer they work out of doubles as signage on CBCW. Although this program is an excellent for Lake Metonga, it still leaves two other public boat landings unattended. The Forest County Veteran's Memorial Campground and public boat landing on the south side of the lake is arguably one of the most active boat landings, especially for tourists. The

Town of Lincoln boat landing on the east shore of Lake Metonga is an undeveloped boat landing with no pier and no onsite parking. Although Lake Metonga already contains aquatic invasive species (AIS), including Eurasian water milfoil, zebra mussels, and rusty crayfish, it is still important to minimize the chance that other AIS be introduced into the system and that existing AIS are not transported to other waterbodies. To that end, the LMA will initiate a WDNR CBCW watercraft inspection program at all Lake Metonga public access sites.

Action Steps:

1. Investigating blocking trailer access to Town of Lincoln boat landing on east shore of Lake Metonga allowing only carry-in access.
2. Enhance Mole Lake and WDNR efforts.
3. Write grant to provide matching funds for Mole Lake's contributions to encompass all Lake Metonga public boat landings.
4. Members of association attend Clean Boats Clean Waters training session during spring or summer 2008.
5. Training of additional volunteers completed by those trained during 2008.
6. Begin inspections during high-risk weekends.
7. Report results to WDNR and LMA.
8. Promote enlistment and training of new of volunteers to keep program fresh.

Management Action: Coordinate annual volunteer monitoring of Aquatic Invasive Species
Timeframe: Start 2008
Facilitator: Planning Committee
Description: In lakes without Eurasian water milfoil, early detection of pioneer colonies commonly leads to successful control and in cases of very small infestations, possibly even eradication. Even in lakes where these plants occur, monitoring for new colonies is essential to successful control. Although the intensity of Eurasian water milfoil in Lake Metonga requires professionally conducted surveys, Eurasian water milfoil occurrences mapped by the volunteers will be used as supplemental information for the professional monitoring efforts.

Volunteers from the LMA will monitor Eurasian water milfoil and other aquatic invasive species within Lake Metonga using training by Onterra staff during the summer of 2008 and during a more intense course in the summer of 2011. Initial training will include identification of target species and native look-a-likes, proper use of GPS for recording aquatic plant occurrences, note taking, and transfer of data. Over the course of the project, it is anticipated that a core group of volunteers with considerable levels of dedication to the continued monitoring program would emerge. These volunteers would participate in a more intense session aimed at training them to use association's GPS, transfer and inspect data from that unit, create preliminary treatment areas, and qualitatively assess treatment efficacy. In the end, the ultimate objective is to have a group of volunteers prepared to carry on a portion of the Eurasian water milfoil control program.

Action Steps:

Please see description above.

<u>Management Action:</u> Control Eurasian water milfoil infestation on Lake Metonga using herbicide applications.

Timeframe: Initiate 2008

Facilitator: Planning Committee with professional help as needed

Description: As described in the Aquatic Plant section and elaborated upon within the Summary and Conclusions, Eurasian water milfoil levels are such in Lake Metonga that the most feasible management technique for its control is herbicide treatments. The responsible use of this technique is well supported by Lake Metonga riparians as indicated by almost 75% of stakeholder survey respondents indicating that they either moderately or highly supportive of an herbicide control program (Question 19). Further, successful herbicide treatments were documented during 2007.

Traditionally, treatment success has been inconsistent at best in Lake Metonga. However, recent changes in the dosage strategy have proven successful and promising. Still uncertainties exist as to why one of the areas treated in 2007, which appeared much the same as the other areas, did not experience good control. As described above, higher herbicide dosage on dense, deep colonies may be required to achieve control within the first treatment year; therefore one area (Map 7, Site K) is proposed for an experimental treatment at 200 lbs/acre. Close monitoring of this area will enhance our understanding of appropriate herbicide use in Lake Metonga.

Research on residual 2, 4-D in the aquatic system after an herbicide treatment is the focus of current studies (e.g. Eagle River Chain of Lakes, Big Sand Lake). Currently in its infancy, residual 2, 4-D testing will allow an understanding of residence time of specific chemical components in the aquatic system. Once a protocol emerges, residual 2, 4-D testing should be included on Lake Metonga, specifically when experimental herbicide treatments (such as 200 lbs/acre) are being completed.

As a part of this control program, Eurasian water milfoil occurrences will be surveyed and mapped annually during the late summer or early fall allowing for accurate determination of treatment areas. The objective of the program will be two-fold 1) reduce overall occurrence of Eurasian water milfoil on a lake wide basis and 2) minimize or possibly eliminate areas of Lake Metonga that are dominated by Eurasian water milfoil. By meeting this objective, the expansion of Eurasian water milfoil within the lake will be minimized as would the plant's negative impact on the recreational use and ecology of the lake.

Qualitatively, a successful treatment on a particular site would include a reduction of Eurasian water milfoil density as demonstrated by a decrease in density rating. For example, areas exhibiting densities of D=2 would be required to decrease to at least D=1. In terms of a treatment as a whole, at least 75% of the acreage treated that year would decrease by one level of density as described above for an individual site.

Quantitatively, a success treatment on a specific site and as a whole would include a significant reduction in Eurasian water milfoil frequency following the treatments as exhibited by at least a 50% decrease in Eurasian water milfoil frequency from the sub-sampling. In other words, if the Eurasian water milfoil frequency of occurrence before the treatment was 80%, the post treatment frequency would need to be 40% or lower for the treatment to be considered a success for that particular site. Further, there would be a noticeable decrease in rake fullness ratings within the fullness categories of 2 and 3. Preferably, there would be no rake tows completed during the post treatment surveys exhibiting a fullness of 2 or 3.

Action Steps:

1. Complete summer/fall Eurasian water milfoil inventory.
2. Prioritize areas for treatment.
3. Apply for conditional treatment permit with WDNR.
4. Complete spring surveys and refine treatment areas as applicable.
5. Notify WDNR of any alterations to original treatment areas so they may issue final treatment permit.
6. Licensed contractor completes chemical application.
7. Assess results based upon pre- and post treatment monitoring.
8. Complete annual inventory.
9. Reapply control as necessary and warranted by successful results of previous treatments.

Management Action: Control Eurasian water milfoil infestation on Lake Metonga using experimental hand-removal techniques.

Timeframe: Initiate 2008

Facilitator: Planning Committee with professional help as needed

Description: Hand-removal by divers is still an experimental procedure for Eurasian water milfoil control; however, the method appears sound. Hand-removal may be useful in areas where plants or colonies are too scattered to warrant chemical treatment, in areas where small, dense colonies occur, and as a supplement to chemical treatments. All of these scenarios currently exist in Lake Metonga and are likely to increase in the future through the success of this plan.

The objective of this action is to discover is hand-removal can be used as a feasible method of Eurasian water milfoil control in Lake Metonga. First, a known site in the northwest corner of the lake consisting of a small, dense colony in approximately 10 feet of water will be monitored using WDNR protocols and submerged video (Map 7, Site M-08). Following the pre-treatment documentation, all of the Eurasian water milfoil plants will be removed from the area (root and all). Post treatment monitoring using the same techniques as the pretreatment monitoring will be utilized to determine the techniques success. If success is apparent, the method will be utilized and tested in other areas of the lake. Please note that Site M-08 is included within the conditional permit for the 2008 chemical treatment in case it is deemed too large for hand-removal techniques at the time of the pretreatment survey. At this time, a more applicable location will be selected.

Action Steps:

Please see description above.

Management Action: Monitor native and non-native aquatic plants on a lake wide basis in Lake Metonga.

Timeframe: Initiate 2011

Facilitator: Planning Committee with professional help as needed

Description: Much of the discussion within the study results pertaining to treatment effectiveness revolve around monitoring that was completed in and near the known locations of Eurasian water milfoil colonies, of which the majority are treatment areas. Although repeating these surveys at specific times of the year can lead to an understanding of how the native and non-native plant communities are reacting to the treatments, that data can only be used to make those determinations within the treatment areas and cannot be extrapolated to the effects on the entire lake. This is especially true of the non-target (native) plants. To determine the effects of the control program on a lake wide basis, a survey must be completed that inventories the lake's entire plant community.

The crux of this action will be the repeat completion of the whole lake point-intercept survey completed in 2005. The data collected during the 2011 survey will be compared with the 2005 data with the intent of determining the success of the control plan on a lake wide basis and the impact of it on the native plant community of Lake Metonga. The data collected as a part of this goal would be beneficial to meeting Management Goal 2.

Action Steps:

Please see description above.

Management Goal 2: Creation of an updated lake management plan for Lake Metonga.

Management Action: Creation of an updated lake management plan for Lake Metonga.

Timeframe: Initiate 2011

Facilitator: Board of Directors

Description: The management of Eurasian water milfoil is not an exact science and by initiating the adaptive strategy outlined in Management Goal 1, much information relating to Eurasian water milfoil will emerge. At this point, the management plan for Lake Metonga will need to be revisited to include the changes in management strategy.

With the pressing concern of Eurasian water milfoil control in Lake Metonga, applicable lake management goals were not given enough attention. After three years, the management of Eurasian water milfoil following the first management goal will be established, allowing for the development of more traditional lake management goals. Preliminary topics of interest that emerged from the planning process include understanding impacts of the City of Crandon's storm water system on the watershed, internal nutrient dynamics of Lake Metonga, impacts of other AIS including zebra mussels and rusty crayfish, and shoreland restoration.

Along with addressing the above management topics, the updated lake management plan would update aquatic plant and water quality data. Comparisons of the 2005 point-intercept and community mapping plant data with more current data will provide an understanding of changes in the aquatic plant community and may indicate changes in ecological health of the system. Similarly, differences in water quality parameters can indicate changes in the ecological health of the system. Members of the LMA collect water quality as a part of the advanced Citizens Lake Monitoring Network and this data will be analyzed against available historic data.

In August 2010, the Lake Metonga Association will apply for a WDNR Planning Grant to create an updated Lake Management Plan for Lake Metonga based on then description above as well as WDNR advisement of criteria needed for an approvable updated plan.

Action Steps:

Please see description above.

METHODS

Lake Water Quality

Historic water quality data was collected using the Wisconsin Department of Natural Resources' Surface Water Integrated Monitoring System (SWIMS). Much of the data utilized was collected by members of the LMA that are enrolled in the advanced program under the Citizen's Lake Monitoring Network.

Aquatic Vegetation

Curly-leaf Pondweed Survey

Surveys of curly-leaf pondweed were completed on Lake Metonga during a June 23, 2005 field visit, in order to correspond with the anticipated peak growth of the plant. Visual inspections were completed throughout the lake by completing a meander survey by boat. Submersed aquatic video was used on an area that once contained this plant species.

Comprehensive Macrophyte Surveys

Comprehensive surveys of aquatic macrophytes were conducted on the system to characterize the existing communities within each lake and included inventories of emergent, submergent, and floating-leaved aquatic plants within them. The point-intercept method as described in "Appendix C" of the Wisconsin Department of Natural Resource document, Aquatic Plant Management in Wisconsin, (April, 2005) was used to complete this study on August 8-11, 2005. A point spacing of 80 meters was used resulting in approximately 1311 points.

Community Mapping

During the species inventory work, the aquatic vegetation community types within each lake (emergent and floating-leaved vegetation) were mapped using a Trimble GeoXT GPS data collector with sub-meter accuracy. Furthermore, all species found during the point-intercept surveys and the community mapping surveys were recorded to provide a complete species list for the lake.

2007 Treatment Monitoring

The methodology used to monitor the 2007 herbicide treatments is included within the results section under the heading: *Treatment Monitoring*.

Watershed Analysis

The watershed analysis began with an accurate delineation of Lake Metonga's drainage area using U.S.G.S. topographic survey maps and base GIS data from the WDNR. The watershed delineation was then transferred to a Geographic Information System (GIS). These data, along with land cover data from the Wisconsin initiative for Statewide Cooperation on Landscape Analysis and Data (WISCLAND) were then combined to determine the watershed land cover classifications. These data were modeled using the WDNR's Wisconsin Lake Modeling Suite (WiLMS) (Panuska and Kreider 2003)

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